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IRON AND STEEL ENGINEER

VOL. XIV APRIL • 1937 NO. IV

CONTENTS

Tubular Recuperators Applied to Continuous Reheating Furnaces—by W. H. Fitch, Manager Recuperator Department, The Carborundum Company, Refractory Division, Perth Amboy, N. J. 17

Furnace Pressure and Temperature Control for Side Door Heating Furnaces—by M. J. Conway, Fuel Engineer, Lukens Steel Company, Coatsville, Pa. 30

Furnace Atmosphere—by A. J. Fisher, Combustion Engineer, Bethlehem Steel Company, Sparrows Point, Md. 35

Latest Design and Equipment For The Industry 44

Bethlehem's Continuous Mill, Lackawanna, N. Y. B-1

Republic Steel Opens New Tin Plate Mill at Niles, Ohio 76

Official Program—Spring Engineering Conference 81

Items of Interest 86

Index To Advertisers 6

Association Activities 9

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PLASTIC BINDING U. S. PATENT NO. 1970285 LICENSE NO. 31

Six 3500-hp. Westinghouse d-c. motors drive the finishing stands of Youngstown's continuous hot strip mill. At the right are the two 6,000-kw. synchronous motor-generator sets which supply the motors with d-c. power.

Excellent commutation is one of the features of the four 3,000-hp., one 2500-hp. and one 400-hp. Westinghouse d-c. mill motor which drives the finishing stands at the Ford steel plant at Dearborn, Mich.

This 5,000-hp., 82-rpm. Westinghouse motor is the largest diameter synchronous motor installed in steel mill service. It has been driving a geared continuous sheet and billet mill at the Columbia Steel Corp., Pittsburg, Calif. for many years and is a fine example of "more mileage" obtainable from Westinghouse motors.

Factory-assembly simplified installation of this control board in the Ford hot strip mill.

★

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* "More Mileage"—Convert the turning motion of an electric motor into distance and you'll be amazed at the *mileage* that can pile up during its lifetime. Make sure of *more mileage*—longer, trouble-free life—by specifying Westinghouse motors and control for the tough drives in your plant. J 93235

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A PERMANENT Electrical Conduit—FOR SERVICE THAT'S REALLY TOUGH!

ELECTRICAL CONDUIT in steel-mill service must be able to meet the most rigorous of demands . . . and meet them with permanent efficiency.

It must offer thorough adaptability . . . assure effectiveness above ground or below . . . indoors or out . . . under a wide variety of severe service conditions.

Consider the suitability of Transite Conduit for such conditions. Strong enough to be laid without a concrete envelope, Transite Conduit eliminates concreting costs and thus effects major installation savings. And Transite Conduit—an asbestos-cement product—is resistant to corrosion, immune to rot or decay . . . virtually free from maintenance throughout its long life.

Above ground—in all exposed locations—this durable material is incombustible, weatherproof and unharmed by smoke or most corrosive fumes. Hence you are assured of a conduit that permanently and economically safeguards your electrical distribution systems.

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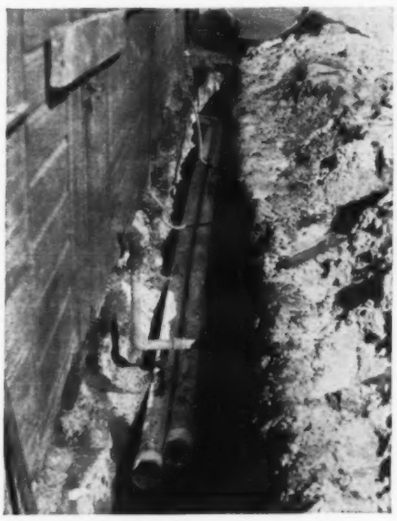
For complete information on Transite Conduit and Transite Korduct (described below), write to Johns-Manville, 22 E. 40th Street, New York City.



UNDERGROUND, Transite Conduit is so strong it needs no concrete envelope . . . hence assures important installation savings. And even under severe service conditions, its permanence assures years of virtually maintenance-free service.

ON ALL EXPOSED LOCATIONS, Transite Conduit provides continued economical service. Thoroughly adaptable, its durability, incombustibility and immunity to rot and decay, combine in making it the perfect answer to steel-mill conduit needs.

USE J-M KORDUCT FOR "CONCRETING-IN"

Possessing all the advantages of Transite Conduit . . . but offering lesser wall thickness . . . and lower cost . . . J-M Transite Korduct is the conduit to use on all duct systems where a concrete envelope is necessary. Korduct's light weight and long lengths sizably reduce both material and handling expense.

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INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Company 64
Allis-Chalmers Manufacturing Company 123
Aluminum Company of America 111
American Hammered Piston Ring Division of Koppers Company 126–127
Askania Regulator Company 122
Automatic Nut Company 70

B

Bailey Meter Company 54–55
Baker-Raulang Company 12
Bantam Bearings Corporation 75
Bartlett Hayward Division of Koppers Company 126–127
Bonnot Company 8
Bristol Company 107
Edgar E. Brosius, Incorporated 119
Bull-Dog Electric Products Company 7
Burgess Battery Company 110
Bussmann Manufacturing Company 78–79

C

Carborundum Company 16
Clark Controller Company 115
Cleveland Worm & Gear Company 68
Columbia Electric Manufacturing Company 114
Crescent Insulated Wire & Cable Company, Inc. 71
Crocker-Wheeler Electric Mfg. Company 105
Cutler-Hammer, Inc. ..... Cover 2

D

Dings Magnetic Separator Company 116
De Laval Steam Turbine Company 108
Joseph Dixon Crucible Company 112

E

Edison Storage Battery 125
Electric Controller & Manufacturing Company 11
Electric Furnace Company 10
Electric Service Supplies Company 121
Electric Storage Battery 120
Elwell-Parker Electric Company 85
Engineering & Construction Div. of Koppers Co. 126–127

F

Farrell-Birmingham Company, Inc. 119
Farval Corporation 130
Frazier-Simplex, Incorporated 74

G

Gas & Coke Division of Koppers Company 126–127
General Electric Co. 13–52–53–92–106–129–Cover 4

H

Holophane Company, Inc. 73
C. B. Hunt & Son 2
Hyatt Roller Bearing Division of General Motors 65

I

Independent Air Filter Company 113
I-T-E Circuit Breaker Company 61–Cover 3

J

Jefferson Electric Company 89
Johns-Manville 5–69

K

Koppers Company 126–127
Koppers Coal Company 126–127
Koppers-Rheolaveur Company 126–127

L

LeCarbone Company 103
Leeds & Northrup Company 49
Lewis Foundry & Machine Company 97
Lincoln Electric Company 80
Lintern Corporation 106

M

Mackintosh-Hemphill Company 101
Maryland Drydock Company 126–127
Mathews Conveyer Company 15
McKay Machine Company 72
Mesta Machine Company 50–51
Metal & Thermit Corporation 102
Morgan Construction Company 128
Morgan Engineering Company 96

N

National Lumber & Creosoting Company 126–127
New York and New Jersey Lubricant Company 122
Norma-Hoffman Bearings Corporation 91

O

Ohio Electric Manufacturing Company 110
Okonite Company 94

P

Pennsylvania Transformer Company 109
Pittsburgh Rolls Corporation 98
Poole Foundry & Machine Company 100
Pyle National Company 93

R

Railway and Industrial Engineering Company 66–67
Reliance and Electric Engineering Company 56–57
Rockbestos Products Corporation 99
Rowan Controller Company 113

S

Schloemann Engineering Company 95
S-K-F- Industries, Inc. 60
Speer Carbon Company 112
Streine Tool & Manufacturing Company 14
B. F. Sturtevant Company 124
Surface Combustion Corporation 58–59

T

Tar and Chemical Division of Koppers Company 126–127
Thompson Electric Company 114
Tool Steel & Gear Pinion Company 104
Trico Fuse Manufacturing Company 117

U

United Engineering & Foundry Company 90

W

Wagner Electric Corporation 63
Wean Engineering Company, Inc. ..... Cover 1
Wellman Engineering Company 118
Western Gas Division of Koppers Company 126–127
Westinghouse Electric & Manufacturing Company 4
White Tar Company of New Jersey, Inc. 126–127
Lee Wilson Engineering Company 1
Wood Preserving Corporation 126–127

ADVERTISING PAGES REMOVED

ASSOCIATION ACTIVITIES

ANNUAL CONVENTION

Chicago, Illinois

SEPT. 28, 29, 30 -- OCT. 1, 1937

The papers committee is now arranging a very attractive and instructive technical program for the annual convention to be held in the Stevens Hotel, September 28, 29, 30 and October 1, 1937. It will be one that every steel mill operator and engineer can ill afford to miss.

●

One of the features of the convention will be the inspection trip to the Gary Sheet and Tin mills of the Carnegie-Illinois Steel Corporation on Wednesday, September 29.

PITTSBURGH DISTRICT SECTION

Inspection Trip

JUNE 23, 1937 -- 1 P. M.

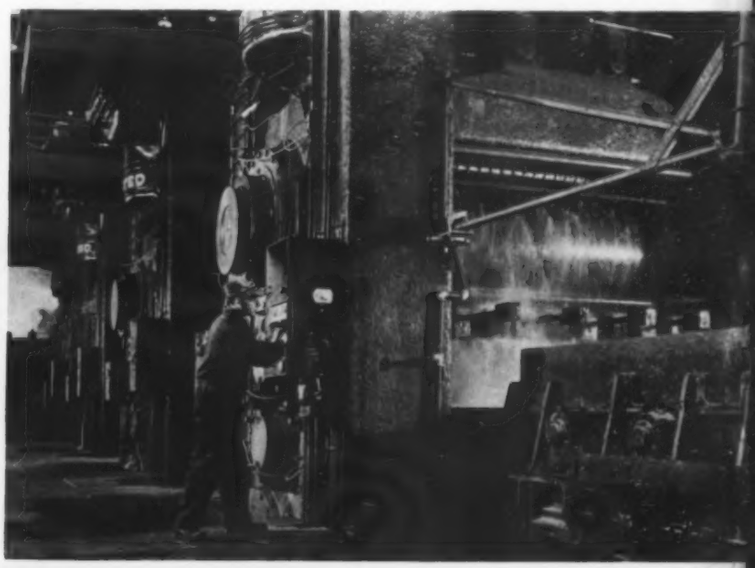
Members and guests of the Association will inspect the new 100" continuous plate mill of the Carnegie-Illinois Steel Corporation at Homestead, Pa., on June 23, 1937. Buses will leave the Grant Street entrance of the Wm. Penn Hotel at 1:00 P.M.

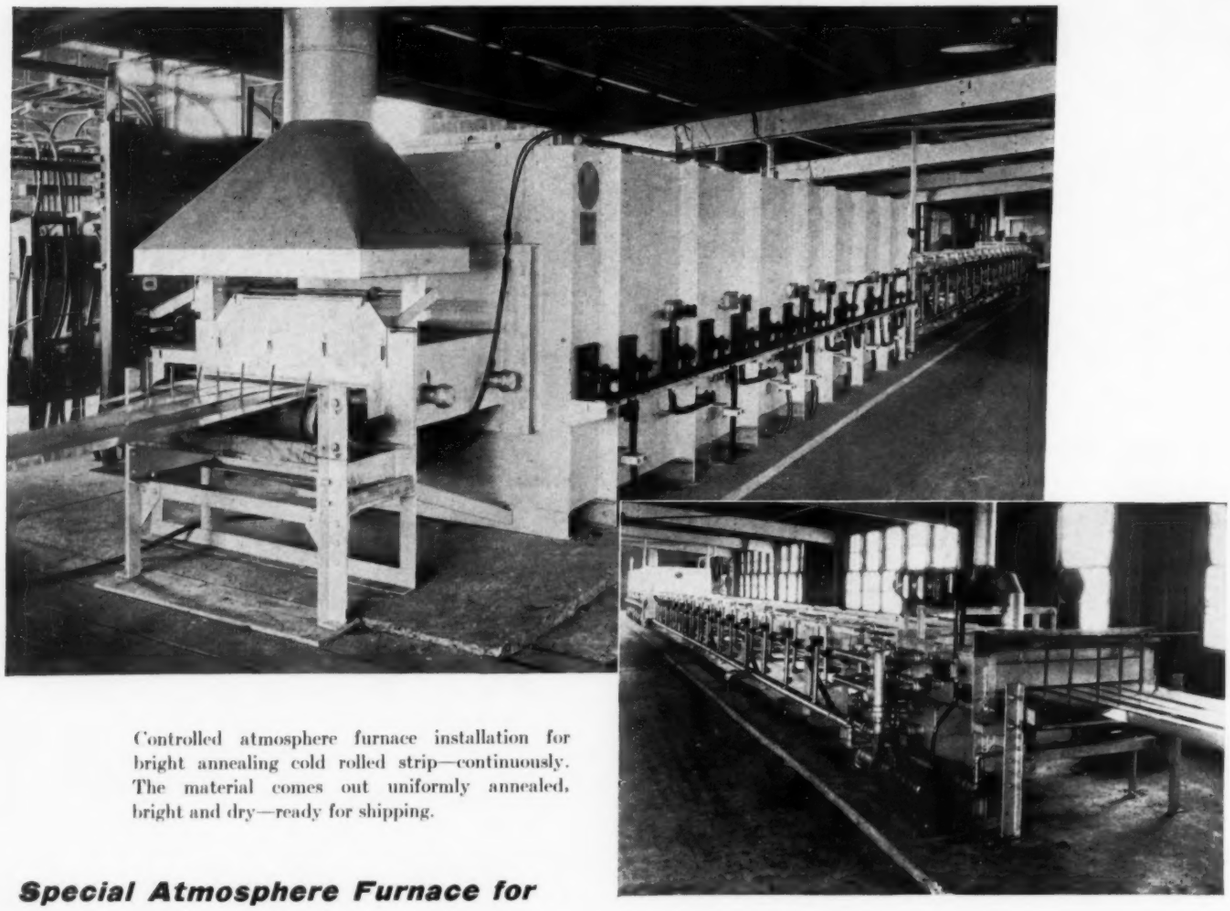
●

"FLOOD CONTROL SYMPOSIUM" at 8:00 P.M., preceded by an informal dinner at 6:30 P.M. Cardinal Room, Wm. Penn Hotel.

Five stand-Tandem Cold Reduction Mill—Gary Tin Mill Carnegie-Illinois Steel Corp., Gary, Ind. Part of plant to be inspected during Annual Convention at Chicago, Ill.

Four High Finishing Train, (4 stands) Carnegie-Illinois Steel Corporation, New 100 Semi-continuous Plate Mill, Homestead, Pa.





Controlled atmosphere furnace installation for bright annealing cold rolled strip—continuously. The material comes out uniformly annealed, bright and dry—ready for shipping.

Special Atmosphere Furnace for

Bright Annealing Strip—Continuously

Quicker deliveries, shorter annealing time and less material in process . . . continuous operation, absolute uniformity of finish and anneal . . . elimination of pickling, smaller floor space requirements and lower operating costs. These are some of the advantages of our continuous controlled atmosphere furnaces for bright annealing cold rolled strip.

The finish and anneal are absolutely uniform as the material is annealed in strip form.

The anneal is secured in a few minutes in place of from 24 to 36 hours . . . requires less material in process.

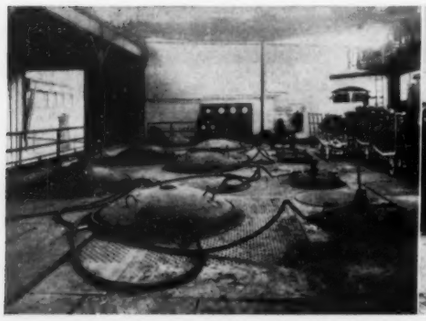
These furnaces can be built in sizes or batteries to handle any width or tonnage required.

Other recent installations include continuous, special atmosphere furnaces for bright or clean annealing ferrous and non-ferrous products, including tubing, wire, strip, sheet, stampings and other finished and unfinished products—continuous furnaces for copper brazing or joining metal parts and for heat treating with complete absence of scale; as well as continuous and batch furnaces of various types for normalizing, annealing, billet heating and other processes.

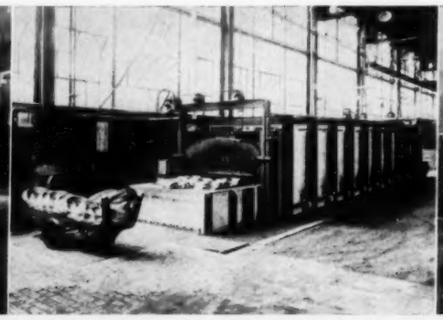
Our engineers will be glad to work with you on any of your annealing or heat treating problems. We specialize on building production furnaces to fit the customer's particular requirements.

The Electric Furnace Co., Salem, Ohio

WE BUILD THE FURNACE TO FIT THE JOB—FOR OIL, GAS OR ELECTRIC HEAT



Normalizing Rod Gas fired pits for normalizing and spheroidizing rod—also built for bright annealing wire.



Annealing Wire Gas fired, continuous, conveyor type furnace for clean annealing wire in coils—continuously.

Annealing Wire Electrically heated pit for annealing special alloy wire in coils—without scale or decarburization.

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TUBULAR RECUPERATORS

Applied to Continuous Reheating Furnaces

By W. H. FITCH, Manager
Recuperator Department
The Carborundum Company
Refractory Division
PERTH AMBOY, N. J.

Presented before the Annual Convention of the A. I. & S. E., Detroit, Michigan, Sept. 22-25, 1936

▲ THIS paper should be prefaced by the statement that The Carborundum Company does not build furnaces or recuperators. Their interest in recuperators is confined to the manufacture of silicon carbide tubes, the design of special material required for their assembly and the application of the recuperator to industrial furnaces.

W. H. FITCH

In the first applications of the silicon carbide tubular recuperator, especially those of large capacity to which this discussion refers, where the responsibility was divided, conditions had to be carefully considered before the buyer could reach a decision and it was only possible to complete and carry out such plans with the help and cooperation of furnace builders and plant engineers who had the courage to act upon their convictions. This is thoroughly appreciated by the writer. The persistency with which furnace builders and operators have clung to the re-recuperative principle for the preheating of air for combustion of fuel, and their search for better recuperator design and efficiency is quite evident judged by the great number of trial installations that have been made during the past several years.

While the majority of the furnaces in question were designed to be fired one way continuously and, therefore, were suitable for application of a recuperator, furnaces with reversal of flame travel were not overlooked. In several instances the recuperative principle has been added to the regenerative reversing furnace with the idea that the operating inefficiencies of the latter could be offset by the addition of the former. This feature was the subject of a paper by the writer at the October 1926 meeting of the Engineers Society of Western Pennsylvania. Incidentally, much progress has been made in the application of the silicon carbide tube recuperator to high temperature furnaces including iron and steel melting, since the paper in question was read, and the statements made then seem too conservative now.

A number of furnaces of the regenerative type have since been rebuilt using silicon carbide tubular recuperators, the checkers and reversing mechanism being completely eliminated. There is sufficient evidence to justify the statement that the recuperative principle is more effective in these applications than were the regenerators previously used. On the strength of this it is reasonable to suppose that greatly improved results can be gained by applying the tubular recuperators to furnaces of larger capacity. Unquestionably this opinion is growing among steel men who seriously questioned such claims a few years ago.

The use of the recuperative principle affords firing in one direction continuously and a constant flow of heat, thereby increasing the rate of furnace production to the maximum—requires the minimum amount of space for building, and costs no more to build with super-refractories than a regenerator system for a given amount of work to be done. In the case of an open hearth furnace rebuild below the floor the air chambers are sufficient to house the tubes that are necessary. With hot producer gas fuel being used, the gas would be conducted direct to the furnace gas ports. Any benefits due to increase in temperature of the gas as a result of passing it through checkers is offset by the cost of the installation and its maintenance.

The building of a recuperator to give satisfactory performance continuously requires great care. Materials that are best suited for the making of the various parts should be carefully selected and then assembled in a practical manner. A great variety of operating conditions must be given consideration if the attempt

is made to apply successfully a given recuperator design to different types of furnaces used in the several industries. Particles that are found suspended in the waste gases in one case do not exist in another. Some of these constituents are more harmful and destructive than others to the heat transfer elements of a recuperator. Wide variation of temperature of waste gases is found. Working cycles of furnaces vary from eight hours to several thousand. Erosion, contraction and expansion, surface accumulation and ease of cleaning and making replacements must be considered. The life of the heat transmitting walls would be shorter in an open hearth than in a continuous reheating furnace. Again the life in a steel melting furnace that runs constantly for many weeks at a time would be greater than in an air furnace operating ten hours out of twenty-four hours. Speed at which the air temperature can be raised and steadiness which can be maintained are factors.

It is apparent that a recuperator should be designed to be completely accessible so that by renewing worn parts a high state of efficiency can be maintained for the recuperator as a whole over a long period of time.

Of all devices that have been used as heat transfer elements in recuperators applied to industrial furnaces in general, silicon carbide tubes have shown outstanding results. In fact, I know of no other material that could be used in many cases.

Careful study of the following is merited by those planning the use of recuperator equipment.

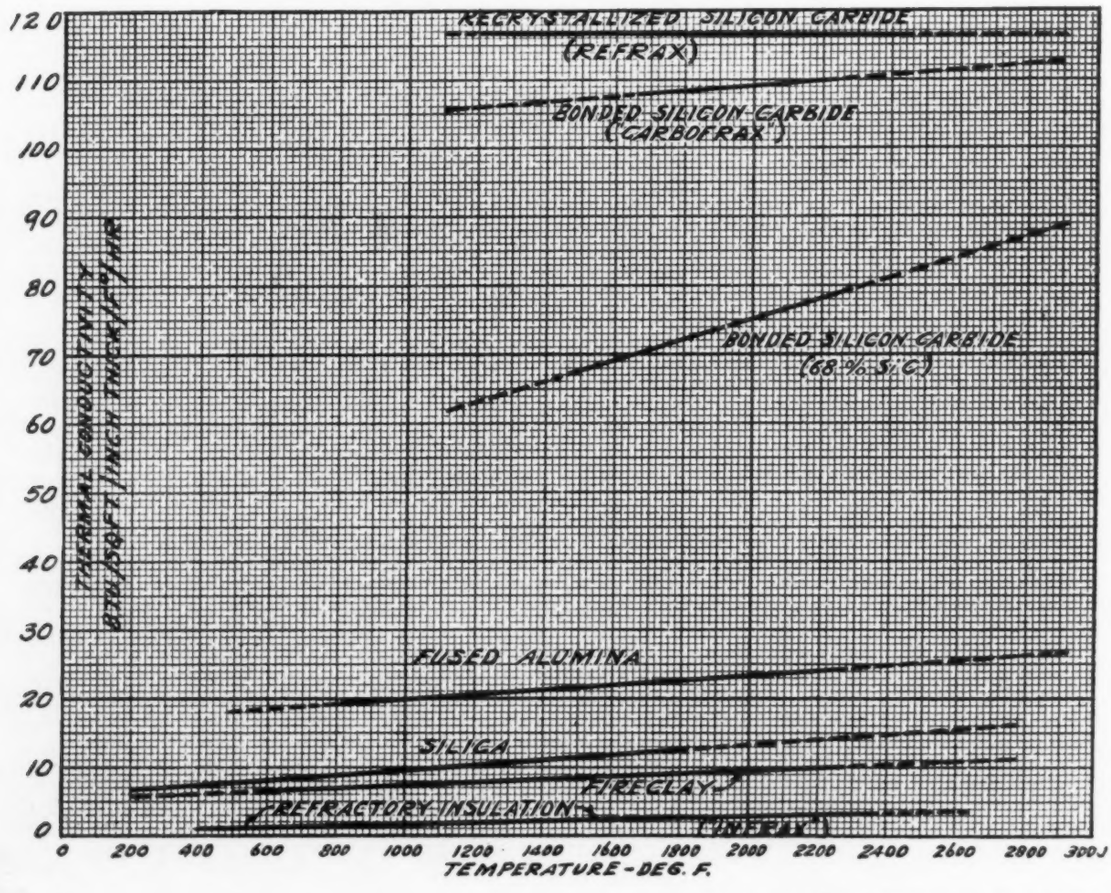
HIGH THERMAL CONDUCTIVITY

"Carbofrax", a bonded silicon carbide refractory, has a thermal conductivity approximately ten times that of fireclay refractories, the curve being a straight line between 105 B.T.U. per hour per sq. ft. per inch of thickness per degree Fahr. difference in temperature at 1100° F. and 112.5 B.T.U. at 2900° F. (See Chart Fig. I.)

REFRACTORINESS

Silicon carbide does not fuse or soften but dissociates chemically at a temperature above 4000° F. "Carbofrax" while not recommended for temperatures closely approaching this dissociation point, is nevertheless capable of withstanding the highest temperatures existing in industrial heating operations.

Fig. I—Thermal Conductivity.



LOW PERMEABILITY

"Carbofrax" is much less permeable to gases than fireclay and most other refractories. Its resistance to leakage due to permeability is ten to one hundred times that of fireclay refractories by actual measurement.

GREAT STRENGTH

"Carbofrax" has an average modulus of rupture of approximately 900 lbs. per sq. in. at a temperature of 1350° C. (2462° F.) Its compressive strength at this temperature is in excess of 10,000 lbs. per sq. in.

FREEDOM FROM SPALLING

"Carbofrax" has never failed through spalling in any industrial application. It has a much lower spalling tendency than other commercial refractories. In a standard spalling test Table I "Carbofrax" shows no loss after one hundred coolings as compared with 4% loss after forty coolings for Grade A fireclay.

TABLE I

"Carbofrax"	0%	at end of			100th	cooling
Grade A Fireclay	4%	"	"	"	40th	"
Bauxite	43%	"	"	"	10th	"
Zirconia (natural)	53%	"	"	"	10th	"
Grade B Fireclay	65%	"	"	"	10th	"
Grade C Fireclay	90%	"	"	"	10th	"
Chrome	100%	"	"	"	7th	"
Silica	100%	"	"	"	4th	"
Magnesia	100%	"	"	"	3rd	"

RESISTANCE TO FLAME ABRASION

"Carbofrax", because of the inherent hardness of silicon carbide and the close-grained, dense structure of the bonded refractory, is highly resistant to mechanical and flame abrasion.

RESISTANCE TO CORROSION BY GASES

A "Carbofrax" tube is, for practical purposes, inert at any temperature encountered in recuperators to all products of combustion of ordinary fuels, including carbon dioxide, oxygen, carbon monoxide, water vapor, nitrogen, sulphur dioxide, sulphur trioxide, hydrogen, etc. See Fig. II.

The silicon carbide tubular recuperator has been applied to about seventy industrial furnaces, in six basic industries including several continuous steel slab and billet reheating furnaces. Additional installations of the latter character are being made at the present time. Incidentally, the total yearly rated capacity of these continuous furnaces, equipped with this heat reclaimer, is over 3.5 million tons of steel

Several recuperator arrangements have been applied to continuous reheating furnaces due to the variation in physical conditions surrounding the furnaces and the quantity and kind of fuel burned per unit of time. Illustrations of these installations with a brief description of each will give a good idea of what has been done in this field generally.

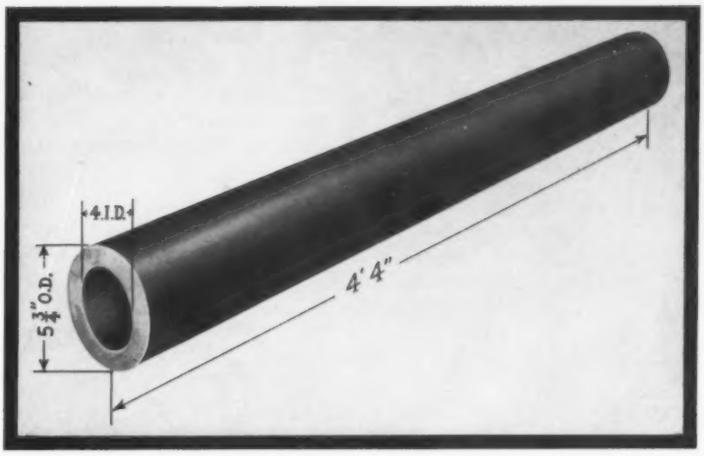


Figure II—Carbofrax Recuperator Tube.

FORD MOTOR COMPANY

Dearborn, Mich.

The first continuous reheating strip mill furnace built with a silicon carbide tubular recuperator is at the Ford Motor Company's plant at Dearborn, Michigan. Two furnaces were installed originally. No. 1 furnace was equipped with the tubular recuperator and No. 2 with a fireclay tile recuperator. Each was designed to heat thirty tons per hour on the basis of steel entering at atmospheric temperature and sixty tons per hour with steel charged at 1400° F. approximately. Both recuperators were designed from the same specifications, i. e. to heat all of the air to 700° F. leaving the recuperator when the furnace was consuming 200,000 cu. ft. per hr. of mixed coke oven and blast furnace gas, averaging 250 B.T.U. per cu. ft., and all of the waste gases entering the unit at 1500° F. It was estimated the temperature of the waste gases would be approximately 2000° F. when the furnace was operated with hot steel charging and at rated capacity.

In the case of the tubular recuperator, 376 tubes were installed, arranged in two banks of 188 tubes each, as shown in Fig. III. Each tube in the coldest bank has one end opened to the atmosphere. The large space between the two banks was made wider than usual because of local conditions. (Ordinarily, this distance need be only slightly over 52" to accommodate a tube 52" long.) The small chamber, connected to the exhauster through a suitable air tight duct, is wide enough to permit a man to enter and inspect or caulk tube ends. Complete accessibility is an important feature of design.

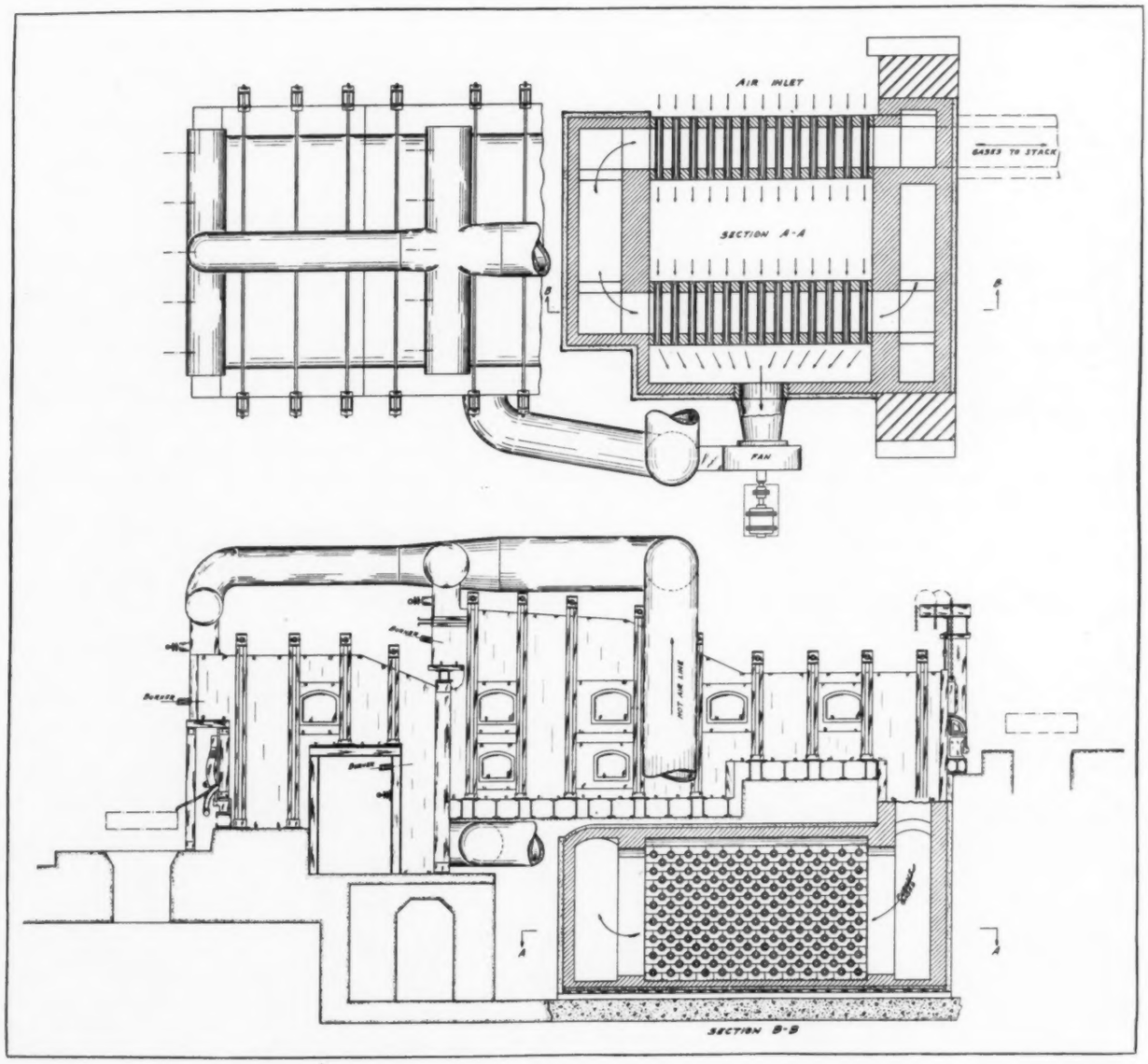
Corebusters are used to increase the inside convection area as well as increase the rate of heat transfer. See Fig. IV.

An important detail of design is the wall blocks. It is necessary to hold the assembly tight enough to prevent leakage at the pressures employed and at the same time permit the movement of the tubes. The desired results are obtained by grinding all contacting surfaces of the blocks and having them recessed or undercut to permit sealing the block joints as well as the tube ends by the use of a cement that is resilient under the working conditions. See Fig. V.

The waste gases enter the collecting flue, flow to one side, and entering the second or hottest pass of tubes in the recuperator, travel in a horizontal path around the tubes. In turn they go through the cross flue and the next pass of tubes, after which they enter the duct to a waste heat boiler.

The recuperator offtake flue is connected to a waste heat boiler which operates in conjunction with an open hearth furnace. An exhauster for removing the combustion gases is placed between the boiler and stack and develops draft of 6″ of water at normal loads. An

Fig. III



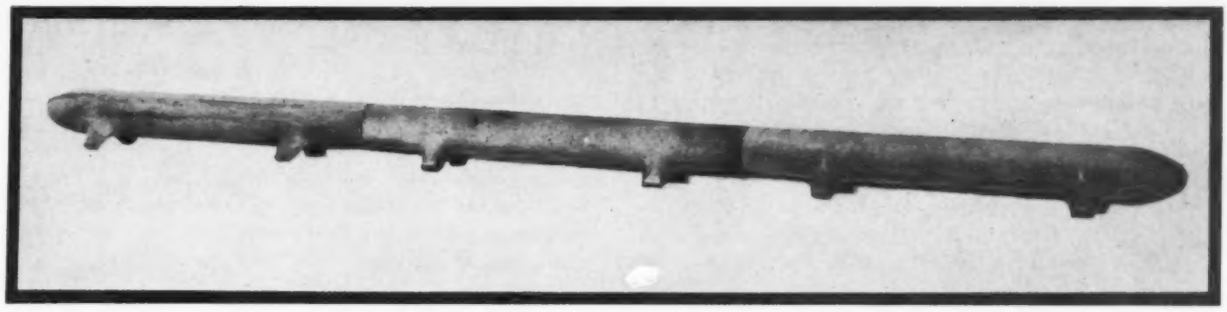


Fig. IV

automatic damper control, installed between the recuperator and the boiler, is operated by gas pressure on the roof of the furnace near the charging end. This pressure is supposed to be .06″ to .08″ water—a figure chosen with reference to good life of the arch.

An exhauster having a capacity of 30000 cu. ft. per minute at 900° F. and 4½″ water driven by a 50 H.P. motor at 1150 R.P.M. for handling preheated air was installed on each of the furnaces. No provision has been made for controlling the temperature of the air entering the exhauster, serving the tubular recuperator. The air temperature from the tubular recuperator has never exceeded 900° F.

An interesting feature of the design was that either recuperator could be replaced by the other type if such a procedure should prove desirable after the furnaces had been run for a sufficient length of time to afford a comparison of results.

In the first few months of operation the furnaces were fired with coke oven gas having a heat value of 577 B.T.U. per cu. ft. Steel at a temperature of approximately 1400° was charged into the furnace. Later this temperature was lowered to between 60 and 400° F. Fuel was changed from gas to oil and after the mill had been "tuned up" the furnaces were worked at a rate very considerably in excess of that for which they were designed. Under these changed conditions draft loss increased considerably. This statement refers to both furnaces.

The distribution of the heat of the waste gases in the recuperator is noteworthy. Viewing the tubes in vertical rows, beginning at the hottest row, the color of all tubes in each row is exceptionally uniform. The color diminishes progressively until it disappears in the last few rows where the waste gases leave the recuperator.

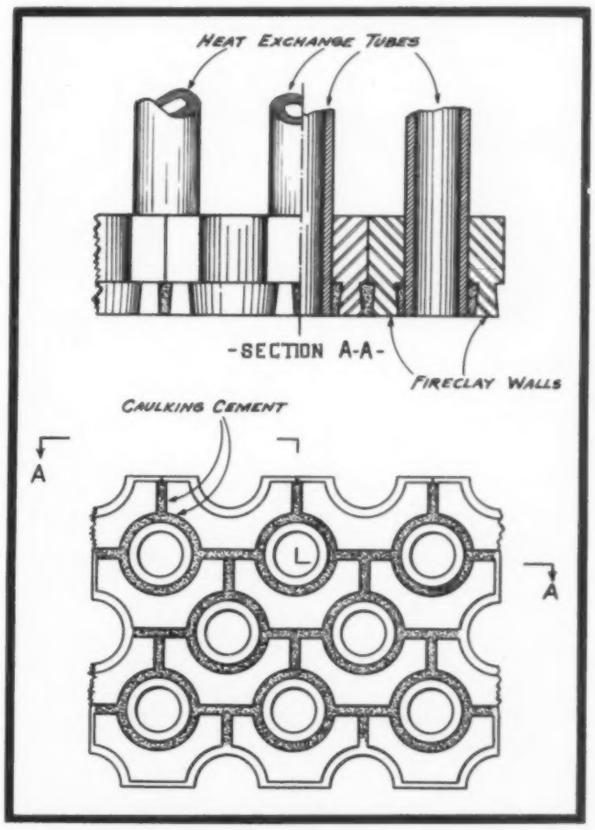
It seems appropriate to mention the large amount of heating surface, in the form of tubes, that was originally installed in No. 1 recuperator; further, that the original design functioned satisfactorily for the amount of work it was designed to do. It is apparent that the tubular recuperator has a much greater heat transfer capacity per unit of heating surface than is possible to obtain with any other type of refractory recuperator of equal overall space requirements.

With the idea of increasing draft area to decrease draft loss, it was found practicable in No. 1 furnace recuperator to take out 100 tubes. The holes in the walls resulting from the removal were closed with plugs made for the purpose. (The tubes that were removed were in perfect physical condition.) Only a few hours time was required for the work after the furnace was cooled. No trouble has been experienced in obtaining all of the air required for combustion after the change. No trace of CO_2 appeared in the hot air outlet chamber.

No alteration could be made in the construction of the fireclay tile recuperator.

After the change in the tubular recuperator was completed a test was made as shown by Log 1, Fig. VI. Table II, Fig. VII shows the capacities designed for and those actually found in practice.

Fig. V



Both furnaces were provided with air gas proportioners which have orifice plates in the two pipes. The drops across these openings permit estimates of the fluid volumes passing. When oil is used the air may still be metered and a rough idea of the amount of fuel obtained by assuming the same percentage deficiency of combustion air as for gas.

The log of the readings taken follows: In it the heading "Gas Differential" refers to the pressure drop in inches of water across the orifice in the gas pipe. "Top", "Bottom" and "Soak" indicate the burners for the roof, below the charge, and for the soaking zone at the furnace discharge end. "Gas Cu. Ft. per Hour" is the total used in the three zones as calculated from the differentials. "Air Differential" and "Air Cu. Ft. per Hour" correspond to the foregoing readings on the gas. "Air Temp." was taken in the insulated fan outlet pipe by a recording potentiometer pyrometer. "Furnace Temp." was obtained from a pyrometer with a platinum couple in the roof of the soaking zone. "Flue Temp. between First and Second Pass" and "Flue Temp. after Second Pass" were read on a portable millivoltmeter using a chromel-alumel couple. All these instruments were checked and corrected figures only were recorded. The readings of February 28th were with the original installation of 376 tubes. Subsequent figures were after the removal of 100 tubes previously mentioned.

Readings taken on orifice drops February 28th showed that No. 1 furnace was burning 176,200 cu. ft. of gas per hour. It was claimed that 150,000 cu. ft. was the proper rate and appropriate adjustments were made. The lower consumption naturally reduced the draft loss as the log shows, but even so the automatic damper could not function as designed.

From the foregoing it is clear that on the basis of 150,000 cu. ft. per hour of coke oven gas the heat release in the furnace was 55% more than the recuperator design provided for and with 176,200 cu. ft. per hour 82% more. The correspondingly higher flue gas velocities were 46% and 71% provided all of the products passed through the recuperator. Evidently this last condition was impossible because the draft was insufficient to draw all the gases into the flues. In spite of the adverse conditions the recuperator was performing remarkably well.

No readings were taken Monday, March 2d, as the furnace was very far from stable and production was poor. On Tuesday, as the log shows, with the charge largely of slabs at a dull red heat the furnace was in a far more satisfactory operating condition than before the changes in spite of the lower air preheat which

Fig. VI

LOG OF NO. 1 REHEATING FURNACE CARBORUNDUM CO. RECUPERATOR
FORD MOTOR CO. NEW STRIP MILL

Date	Feb. 28	Feb. 28	Feb. 28	Feb. 28	Feb. 28	Feb. 28	Mar. 3	Mar. 3	Mar. 3	Mar. 4	Mar. 4
Time	9:45	9:50	10:00	10:45	12:30	12:50	10:10	10:55	12:40	10:10	11:20
Gas Differential Top	8.3	8.3	8.3	8.3	2.5	4.0					
Gas Differential Bottom	2.4	2.4	2.4	2.4	2.4	4.0					
Gas Differential Soak	8.4	8.4	8.4	8.4	4.0	4.0					
Gas cu. ft. per hr.	176,200	176,000	176,200	176,200	124,000	150,000	Oil	Oil	Oil	Oil	Oil
Air Differential Top	1.6	1.6	1.6	1.6	.....	1.0				0.3	1.1
Air Differential Bottom	0.6	0.6	0.6	0.6	.....	1.0				0.5	1.1
Air Differential Soak	1.9	1.9	1.9	1.9	.....	1.0				1.0	1.0
Air Temp. °F.	815°	815°	815°	.....	815°	815°			720°	600°	570°
Air cu. ft. per hr. 60° F.						289,000					
Furnace Temp. °F.	2470°	2470°	2470°	2470°	2470°	2480°	2450°	2450°	2400°	2450°	2450°
Draft reading between 1st and 2d pass	2.0″	2.0″	1.9″	1.4″	2.0″			1.8″			1.6″
Flue temp. between 1st and 2d pass °F.	....	....	....	....	1340°	1340°			1560°		1340°
Draft after 2nd pass.	2.5″	3.0″	2.7″	....	2.2″	2.7″	2.0″	2.0″			1.8″
Flue temp. after 2d pass °F.	....	....	....	1000°	1010°	1010°			1260°		1030°
Flue gas at boiler CO_2%							9.4				
Flue gas at boiler O_2%							7.6				
Flue gas at boiler CO %							0.0				
Flue gas before damper CO_2%							10.0				
Flue gas before damper O_2%							5.0				
Flue gas before damper CO %							0.0				
Flue gas between passes CO_2%								8.0			
Flue gas between passes O_2%								3.0			
Flue gas between passes CO %								0.6			
Draft at boiler							2.2″	2.2″		2.0″	2.0″
Air temp. between passes °F.									360°		
Suction in recuperator air outlet chamber									0.9″	0.6″	1.0″
On No. 2 Furnace											
Air Temp. °F.									720°		
Furnace Temp. °F.									2400°		
Temp. after recup. on gases °F.									1230°		
Temp. between passes on gases °F.									1540°		1320°
Draft between passes on gases °F.											0.8″
Draft at boiler					2.0″				2.0″		2.0″

averaged around 720° F. with oil fuel, atomized by steam. The automatic damper was functioning practically all the time with relatively little flame escaping under the door and the draft at the boiler superheater was around 2″ compared to 3″ previously. The total draft between the boiler and stack fan was reduced from 6″ to 5″, the latter being the figure at which No. 2 furnace and boiler operated. The steam production and superheat were approximately the same on both units. The draft between the passes was 1.8″ on No. 1 and the gas temperature 1560°, 220° more than on February 28th because of the higher temperature of the charge. The suction on the air in the hotter pass was never over 1″ and usually less. Flue gas analyses showed some infiltration of air between automatic damper and boiler, but rather a slight amount in the recuperator and its flues. No CO_2 could be detected with the ordinary Orsat in the air leaving the recuperator.

Some readings were also taken on No. 2 furnace which indicated that the gases between the passes and leaving the recuperator were at nearly the same temperatures as existed at the corresponding locations on No. 1. The draft at the recuperator outlet of No. 2 was 1.6″ as a rule compared to around 2″ on No. 1, but as long as the automatic dampers could function the drafts at the boilers were the same. The air temperature leaving the fan on No. 2 was around 720° with considerable cold air being drawn in through the by-pass opening in the duct leading from the recuperator to the exhauster.

With the idea of further decreasing the draft loss to the minimum that is possible, the tubular recuperator permitted further changes which consisted of raising the end of the recuperator roof nearest the charging end of the furnace and eliminating the cross flue for waste gases between the two passes. This changes the flow of waste gases as per Fig. VIII. This arrangement conforms closely to the design of recuperator in No. 3 furnace now being installed, the exception being that the tubes enter the tube terminal wall only 4½″ which permits a larger amount of waste gas area than obtainable in the No. 1 recuperator. It will be remembered, however, that the essential point is the maximum waste gas area as previously stated.

Referring to heat transfer, with reference to recuprators it is known that high air velocities are essential for the maximum amount of work to be done per unit of heating surface, but it has been said this condition unfortunately cannot be maintained in a refractory type of recuperator due to leakage. This statement makes an examination of the following operating conditions of the tubular recuperator of interest.

Fig. VII—Table II

	Designed	Found	Remarks
Heat value of gas	250	518	
Cu. ft. per hr.	200,000	150,000	
Heat released per hr. (net)	50,000,000	77,600,000	
Cu. ft. air per cu. ft. gas (theory)	2.28	5.05	
Air heated per hr. cu. ft. at 60°	456,000	644,000	85% air actually used; 100% in design
Temperature of air	700°	815°	
Heat to air per hr.	5,450,000	9,090,000	
Flue gas temp. entering	1500°	1690°	
Flue gas temperature leaving	1032°	1010°	
Mean air velocity: ft. per sec.	16.8	25.1	
Mean temp. difference	886°	912°	
Rate of heat transfer	16.5	27.2	
Cu. ft. flue gas/cu. ft. gas (theory)	3.10	5.80	
Flue gas volume: cu. ft. per sec.	574	840	
Flue gas velocity: ft. per sec.	34.2	50.0	True only if all the flue gases enter recuperator.

The air volume supposed to pass through the recuperator when the furnace was burning the maximum amount of fuel per hour—176,200 cu. ft. of 577 B.T.U. gas is 423 cu. ft. per second measured at an average temperature of 437° F. A temperature of 815° is indicated when the air is leaving the recuperator. With an area of 12.2 sq. ft. the air must flow at a velocity of 34 feet per second, which is considerably higher than 7 feet per second, the maximum said to be allowable for the flow of air in the conventional fireclay type recuperator.

The air velocity and leakage problem formed the basis of a large amount of experimental work in our own shops. A test for leakage of air through a tube terminal wall, 75 sq. ft., containing 105 tubes, was made daily extending over several weeks, in which the temperature of the gas side was raised to 2400° F. The total loss of air at 1″ water pressure was 15 cu. ft. per minute as shown on curve Fig. IX.

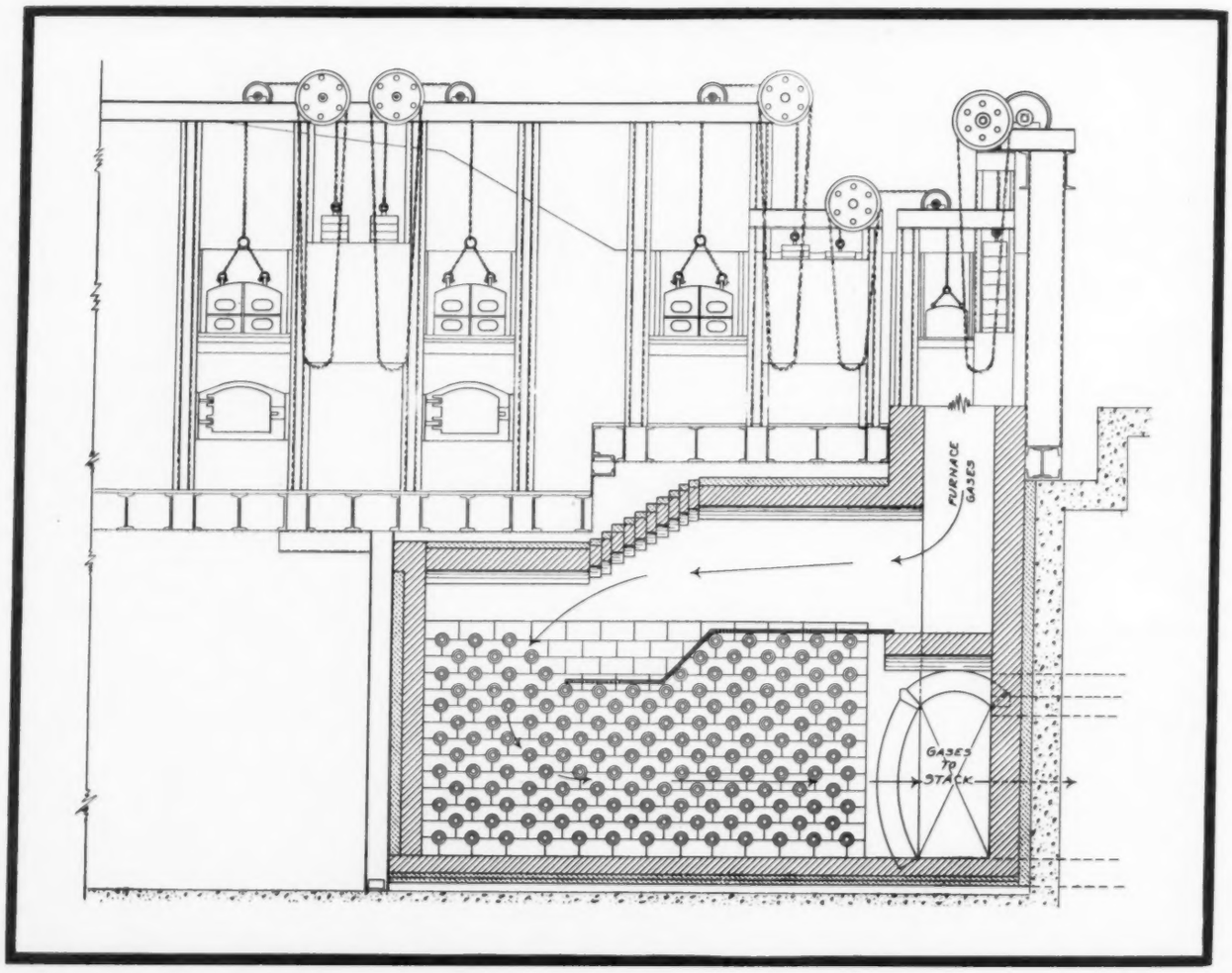
Brief reference to a few other installations that have been made of silicon carbide tubular recuperator application to this character of furnace will show operating conditions which differ from those at the Ford Motor Company plant and all of the data together will give a very good picture as to the adaptability and performance of the tubular type of recuperator in this service.

CARNEGIE-ILLINOIS STEEL CORPORATION
MacDonald Works

The second installation was made at the MacDonald Works of the Carnegie-Illinois Steel Corporation. All three furnaces in the hot strip mill were equipped with silicon carbide tubular recuperators. In this case foundations were made to accommodate the installation of the fireclay tile recuperator in the event of the failure of the tubular recuperator. The extra foundation expense of this procedure was agreed to by the steel plant engineers.

The recuperator was designed to heat all of the air for combustion to 650° F. when burning 600 gallons of tar fuel per hour with the waste gases entering the recuperator at 1450° F. The rated hourly capacity of each furnace was fifty tons of slabs charged at atmospheric temperature.

Fig. VIII



Four hundred eight-four 44″ long tubes were provided for although only 420 tubes were installed. It was decided to place the tube ends only 4½″ inthe terminal walls and thus expose more of the tube to the direct action of the hot gases and in turn reduce the number of tubes required. The holes for the extra tubes were plugged. The recuperator was built in two sections, each containing 210 tubes the latter divided into two passes for the air. The first pass contained 89 and the second pass 121 tubes.

As will be noted in Fig. X the waste gases pass in a horizontal path through each section of the recuperator simultaneously, then turn downward, into separate flues which unite before reaching the stack. The air enters between the two coldest passes, moves towards the charging end of the furnace then flows through the second passes of tubes and travelling down enters the conduit connecting with the exhauster located on a level corresponding with the lowest tube row.

The results have been satisfactory to the owners under all operating conditions to date. The draft loss across the recuperator is .50″ water at maximum rating. The maximum pressure drop on the air passing through the entire recuperator is 1.00″ water as shown on Table III, chart Fig. 12.

CARNEGIE-ILLINOIS STEEL CORPORATION
Homestead Works

The third installation was made at the Homestead Works of the Carnegie-Illinois Steel Corporation. Three 50 ton rated capacity furnaces were equipped. In this installation no provision was made for replacing the tubular recuperator at a later date and the total cost of building this recuperator part of the furnace was substantially reduced over the design installed at MacDonald Works. Each recuperator has 300—52″ long tubes for heating air to 600° F. The tubes are divided in two sections of 150 tubes each. The air enters the tubes on the outside of each bank simultaneously, passes through the tubes and into the preheated air collecting chamber between the two banks of tubes from which it is drawn into the exhauster through suitable connections as per Fig. XI.

STANDARD DESIGN FOR 50-TON FURNACE

After designing several tubular recuperators for this service and studying operating results we have decided that a much smaller recuperator capacity than we originally recommended will do the work. Three hundred sixty 52″ long tubes with 2″ corebusters, divided in two sections of 180 tubes—each section arranged for two passes for air as illustrated, will be satisfactory for heating air to 750° F. with a fifty ton furnace. See Fig. XII.

This construction has the advantages of shortening the length of travel of the waste gases between the furnace outlet ports and the heat transfer elements—provides for the minimum of resistance to flow of waste gases through the recuperator zone—the upward flow of air as it passes from one bank of tubes to the other—permits placing the recuperator under the furnace at a point where the head room is greatest—

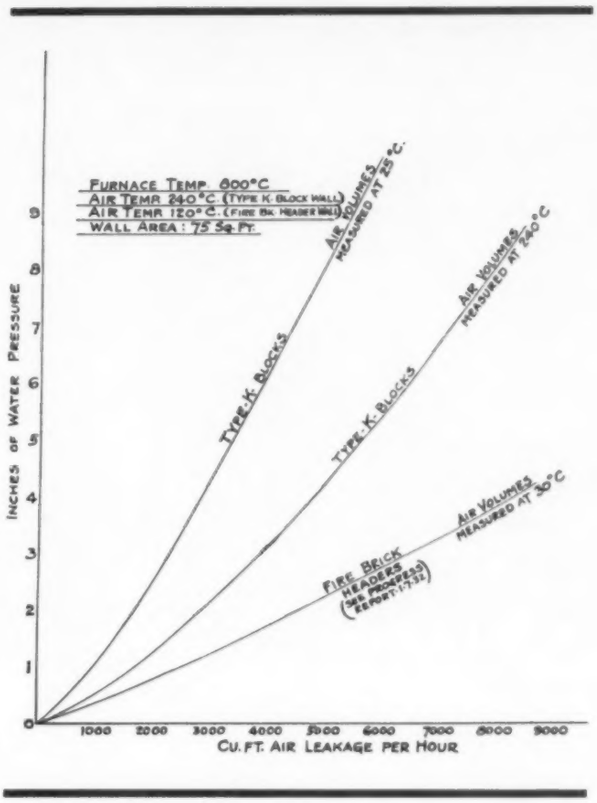


Fig. IX

reduces the length of space required for a recuperator and correspondingly lowers the cost of foundations to a minimum.

RECUPERATORS APPLIED TO EXISTING FURNACES

Two tubular recuperator installations that were made on reheating furnaces originally equipped with metal recuperators will be interesting to some operators who may be contemplating such a change. Resistance to attack by furnace gases containing sulphur, regardless of its condition and temperature, make a highly refractory material like silicon carbide tubes well suited for recuperator work.

Fig. No. XIII illustrates a continuous wire bar reheating furnace fired with hot producer gas that has been operating continuously for over two years with a silicon carbide tubular recuperator. The furnace was built originally for using atmospheric temperature air for combustion. Later it was rebuilt incorporating the large combustion area as well as a metal recuperator for preheating air for combustion. The flue for conducting the waste gases to the stack was extended beyond the side of the furnace, below the ground, in a manner permitting the building of the recuperator over this flue. A by-pass flue, below the ground, equipped with a vertical damper, was installed to permit regulation of the volume of gases flowing through

Table III

LOG OF TEST

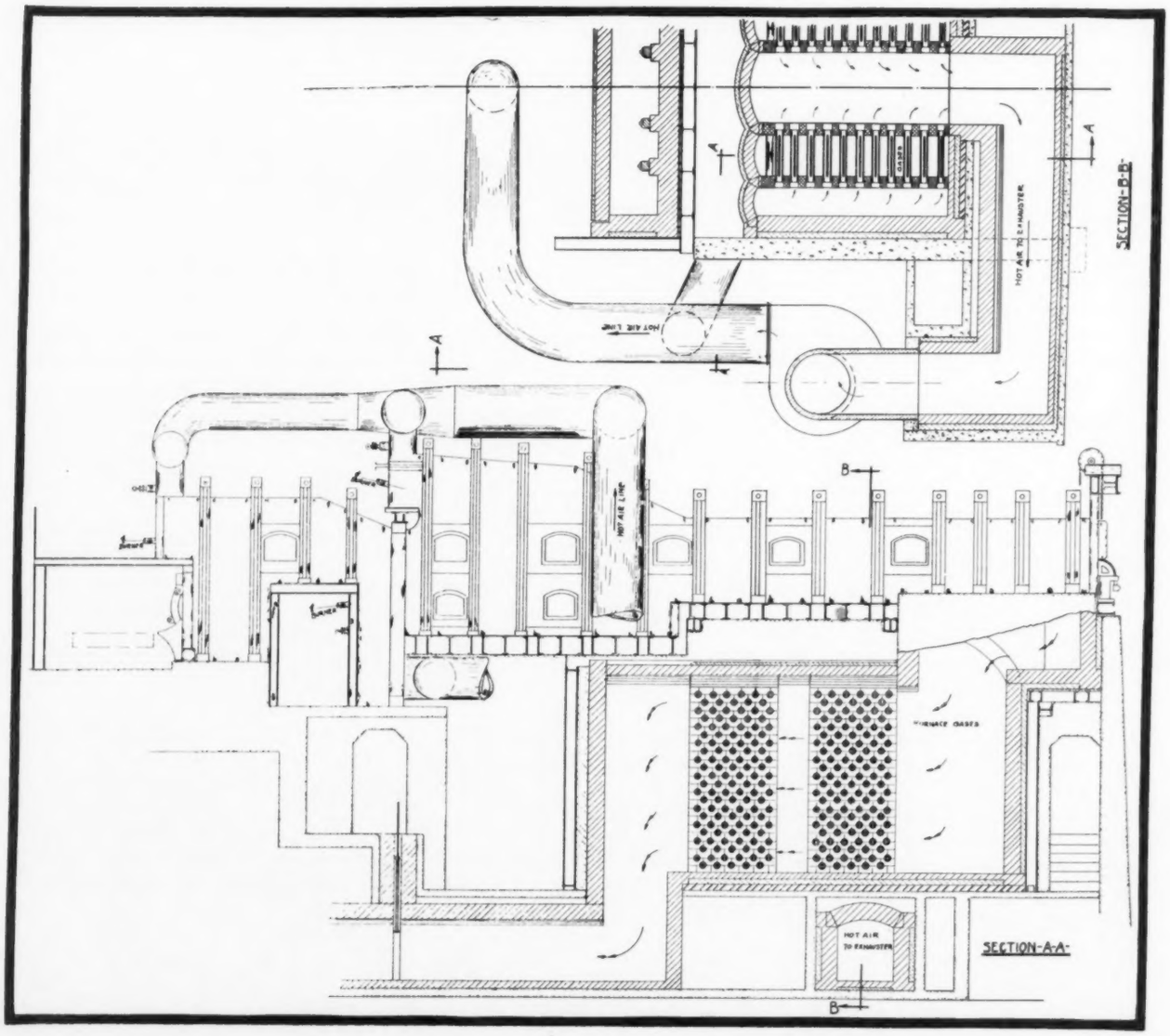
No. 18 Mill—No. 2 Furnace

1:00 — 2:00 P.M. = 76,260 lbs.

2:00 — 3:00 P.M. = 47,040 lbs.

Time	Left Side					Right Side					Gas/hr.	CO_2 Chart	Air Temp. Chart	Gas Temp. in Chart	Gas Temp. Out Chart
	Draft In	Draft Out	CO_2	O_2	CO	Draft In	Draft Out	CO_2	O_2	CO					
10:40	.35	.40				.35	.40	6.9	9.2	0.0	28,000	11.5	500	910	760
10:50	.35	.40				.35	.40				28,000	11.5	495	910	760
1:00	.35	.65				.40	.60				60,000	11.0	420	1020	820
1:15	.35	.55				.40	.55				73,000	11.5	415	1100	860
1:30		.55					.55	9.4	4.5	0.0	73,000	11.5	430	1170	890
1:45	.40	.55				.40	.55				49,000	11.5	450	1050	865
2:00											49,000				
2:15	.40	.55				.40	.55				49,000	11.5	455	1030	850
2:30	.40	.55	6.8	9.2	0.0	.40	.55				49,000	11.5	450	1010	840
2:45	.25	.30				.25	.30				36,000	11.8	480	950	795
3:15	.25	.30				.25	.30				36,000	12.0	470	940	780

Fig. X



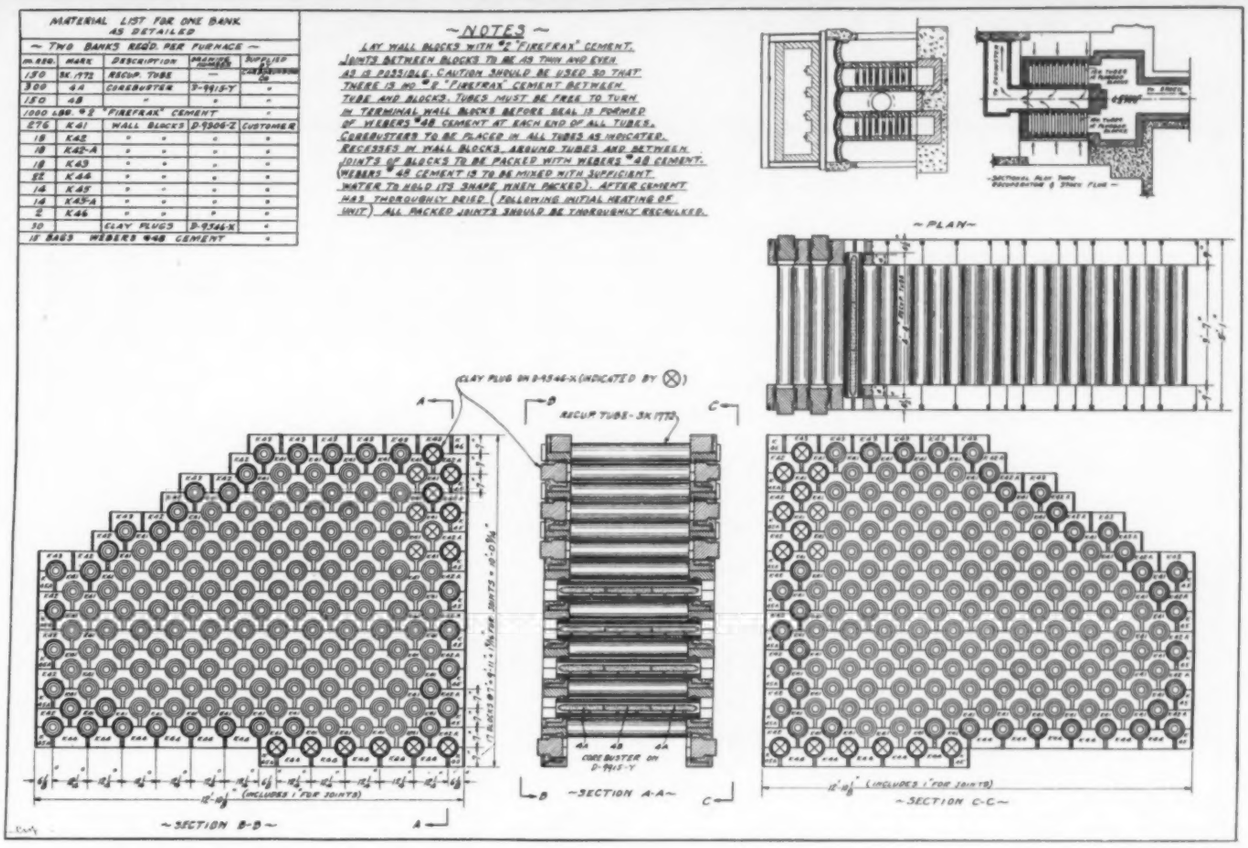
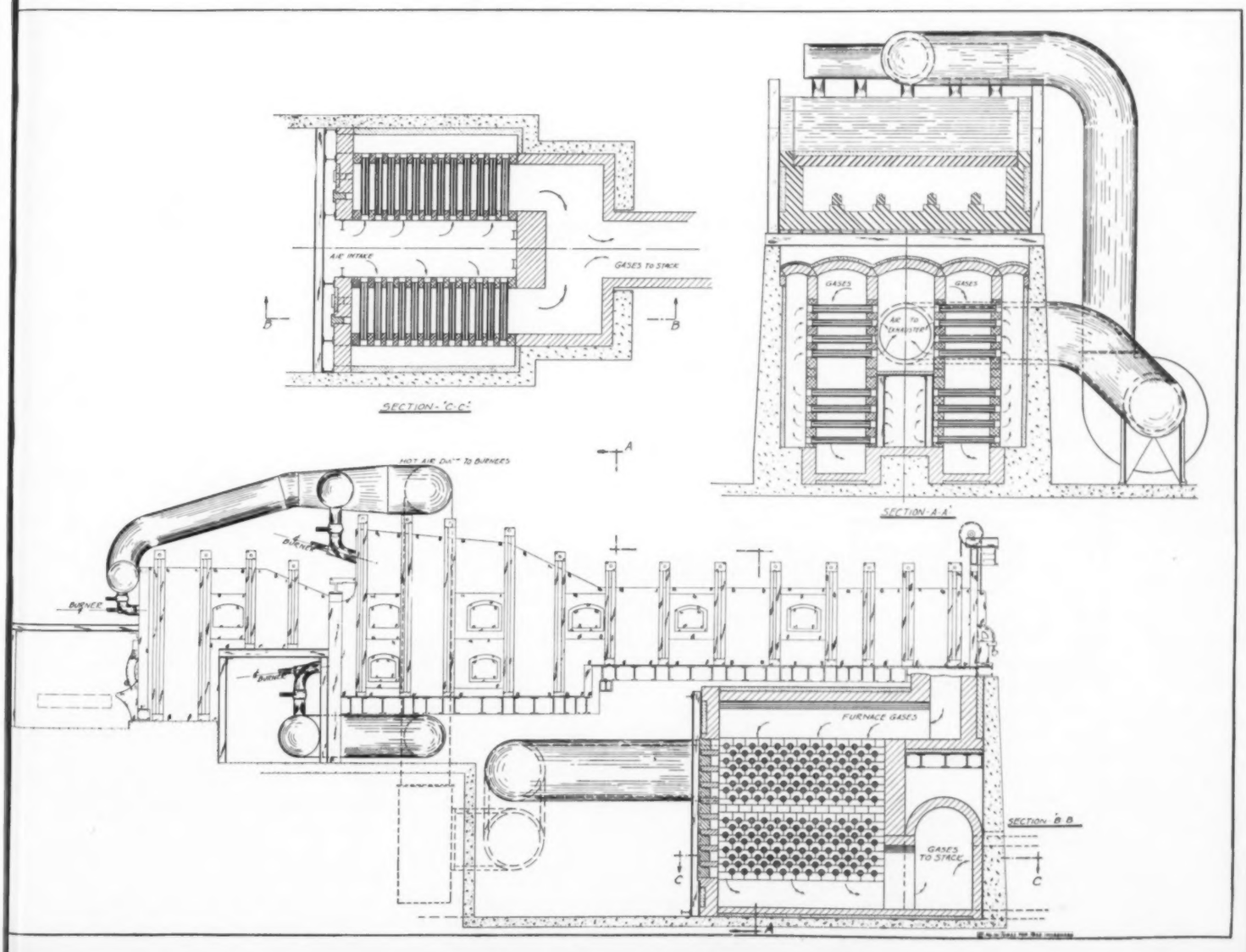

MATERIAL LIST FOR ONE BANK AS DETAILED
~ TWO BANKS REQ'D. PER FURNACE ~
NOTES
LAY WALL BLOCKS WITH "2" "FIREFRAX" CEMENT. JOINTS BETWEEN BLOCKS TO BE AS THIN AND EVEN AS IS POSSIBLE. CAUTION SHOULD BE USED SO THAT THERE IS NO "2" "FIREFRAX" CEMENT BETWEEN TUBE AND BLOCKS. TUBES MUST BE FREE TO TURN IN TERMINAL WALL BLOCKS BEFORE SEAL IS FORMED OF WEBERS "48" CEMENT AT EACH END OF ALL TUBES. CORE BUSTERS TO BE PLACED IN ALL TUBES AS INDICATED. RECESSES IN WALL BLOCKS AROUND TUBES AND BETWEEN JOINTS OF BLOCKS TO BE PACKED WITH WEBERS "48" CEMENT. (WEBERS "48" CEMENT IS TO BE MIXED WITH SUFFICIENT WATER TO HOLD ITS SHAPE WHEN PACKED). AFTER CEMENT HAS THOROUGHLY DRIED (FOLLOWING INITIAL HEATING OF UNIT) ALL PACKED JOINTS SHOULD BE THOROUGHLY RECAULKED.
~PLAN~
CLAY PLUG ON D-9346-X (INDICATED BY ⊗)
RECUP TUBE - 3X 1772
CORE BUSTER ON D-9415-Y
~SECTION A-A~
~SECTION B-B~
~SECTION C-C~

Fig. XI

Fig. XII



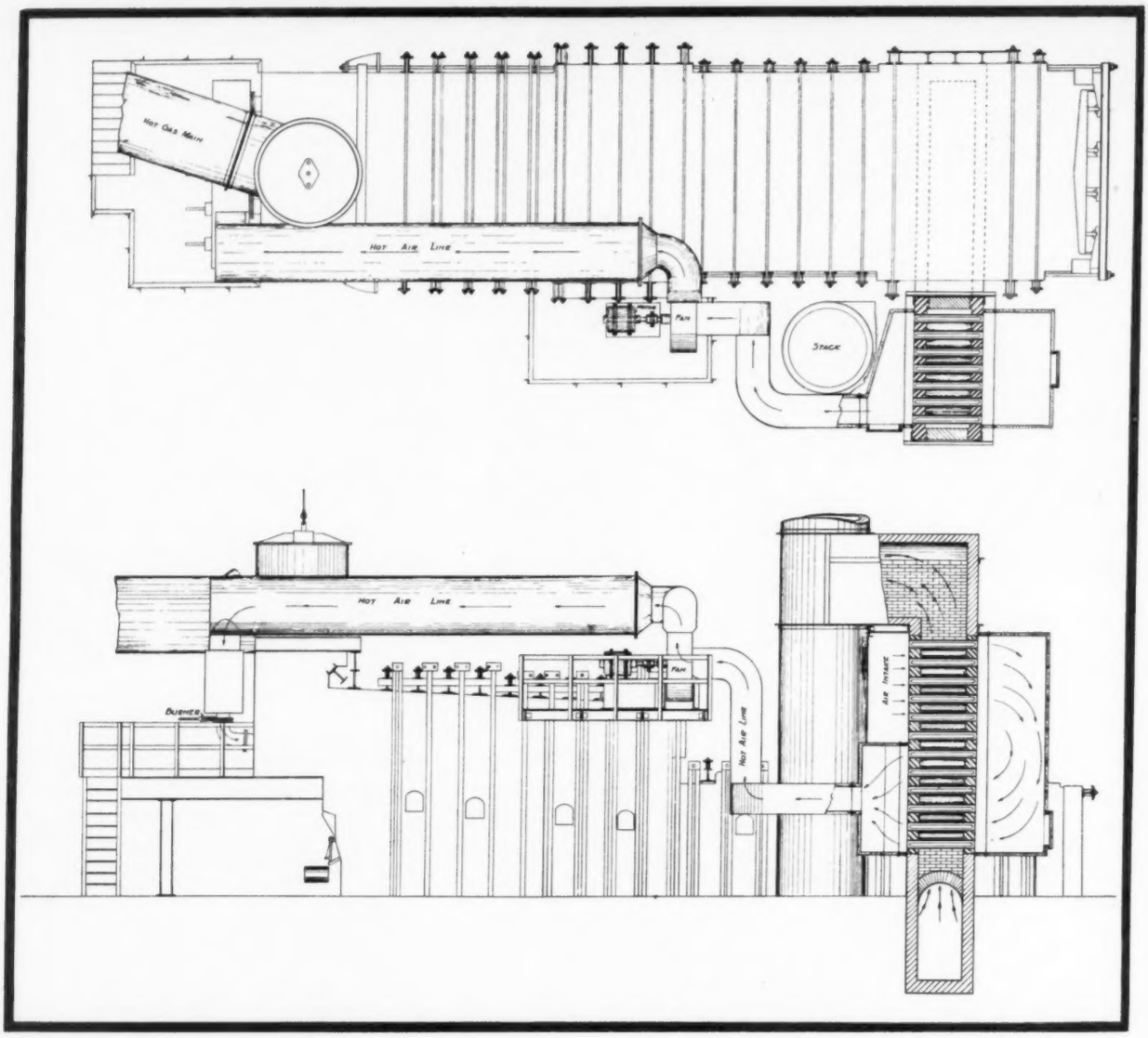


Fig. XIII

the recuperator. A considerable percentage of the total waste gases undoubtedly entered the stack directly from the furnace. The waste gases passing through the recuperator entered the stack at the base of the latter. The air was supplied to the recuperator under pressure. I understand erosion of the metal parts was the greatest obstacle to the success of the metal recuperator.

When the tubular recuperator was installed the wall blocks and tubes were placed in the position formerly occupied by the metal recuperator over the extended waste gas flue and the necessary air boxes and piping were added to convey the air to the exhauster mounted on a platform above the side of the furnace. This permitted a direct hook-up to the pipe line previously used for conveying the air to the burners.

The recuperator contains 144 tubes divided in two passes for air. The air enters the tubes directly from the atmosphere on the stack side of the coldest pass.

In practice with the furnace operating under average conditions, the waste gas temperature is 1200° F. The air temperature at the burners is about 580°. Rated capacity of the furnace is about twenty tons steel per hour.

The pressure on the air at the burners is 11″ of water.

The cost of the tubular recuperator installation, complete including exhauster, motor, piping, etc., was approximately $6000.00.

The second installation of this kind was made on a large capacity continuous reheating furnace, Fig. XIV. This furnace also was previously equipped with a metal recuperator. Again the tubular recuperator was placed in the same position as the metal recuperator previously occupied. Three hundred and twelve tubes, divided in two passes as shown. The waste gas temperature averages 1900° F. entering the recuperator. The air temperature leaving the recuperator averages about 1200° F.

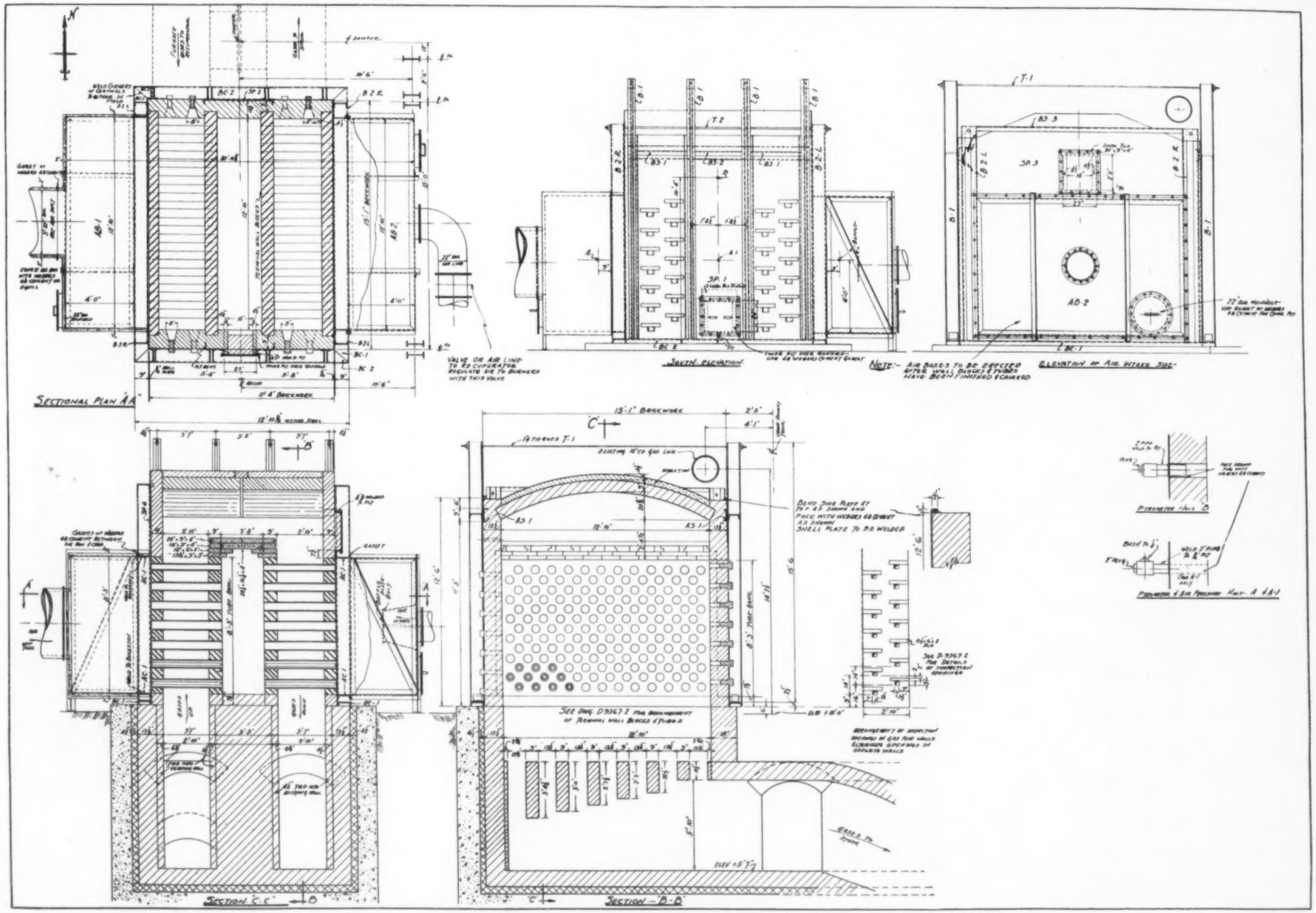

SECTIONAL PLAN AA
SOUTH ELEVATION
ELEVATION OF AIR INTAKE TILE
SECTION C-C
SECTION B-B
See Dwg. D3367 2 FOR ARRANGEMENT OF TRANSVERSE WALL BRACES & TUBES
See D 3367 2 FOR DETAILS OF INSPECTION OPENINGS
ELEV +5'7"
ELEV 16'6"
PIEZOMETER TUBES
PIEZOMETER & AIR PURGING TUBE A & A-1

Fig. XIV

Furnace Pressure and Temperature Control

FOR

SIDE DOOR HEATING FURNACES

By M. J. CONWAY, Fuel Engineer
Lukens Steel Company
COATESVILLE, PA.

Presented before the Philadelphia District Section, A. I. & S. E., February 6, 1937

▲ THE control of furnace atmosphere and pressure in batch type heating furnaces is becoming an increasingly important problem to both fuel engineers and metallurgists.

Much has been accomplished in the subsequent heat treatment after rolling, as is evidenced by the mass of literature dealing with this operation, but practically nothing has been done until recently to properly treat the steel in ingot and slab form previous to rolling, with the possible exception of maintaining a reasonably tight furnace; otherwise, the slogan has been to "get them hot and get them out."

The continual demand for better plates at lower prices has put a greater burden on management. With raw material prices and metallic yield in ingot form fairly well standardized, there are only three points remaining where cost improvement can be made; namely, tons per hour, fuel per ton, and rolling mill yield. Tons per hour is largely a question of furnace and mill facilities and correct sizes for economical rolling. The remaining two items are more flexible and responsive to research.

After ten years of more or less continuous study with both recuperative and regenerative batch type heating furnaces, working under various systems of partial control, we decided that we were ready to recommend the installation of a recuperative side door heating furnace fully controlled.

The heating furnaces in our 84″ mill are the conventional regenerative type shown in Fig. 1, having a hearth length of 28′ 0″ and a width of 9′ 0″ and overall outside brickwork dimensions of 39′ 3″ x 11′ 3″; and as the heating facilities in this mill were inadequate, we decided to add a new furnace of the recuperative type on approximately the same floor space occupied by the existing furnaces.

The new furnace, has a hearth length of 34′ 0″ and a width of 9′ 0″ and overall outside brickwork dimensions of 36′ 3″ x 11′ 3″; and while the outside furnace length is 3′ 0″ shorter than the existing furnace, you will note that we have been able to add 6′ 0″ to the length of the hearth or an increase of 24% to the effective heating space. The reason for this is easily accounted for when a comparison is made between the old and the new furnace ends.—Fig. 2.

M. J. CONWAY

The furnace was constructed by the Surface Combustion Corporation, and equipped with Brown Instrument Company Control, and was put in operation on January 6th, 1937.

The purpose of this paper is to briefly describe its design, method of control, and the results thus far obtained as compared with the conventional renenerative type furnaces operating in the same mill.

The furnace is installed entirely above ground level, and is essentially a tight structure thoroughly insulated, having its recuperators behind the furnace and above ground; and while taking up less space than the older reversing furnaces, every part of the furnace is easily accessible and readily checked.

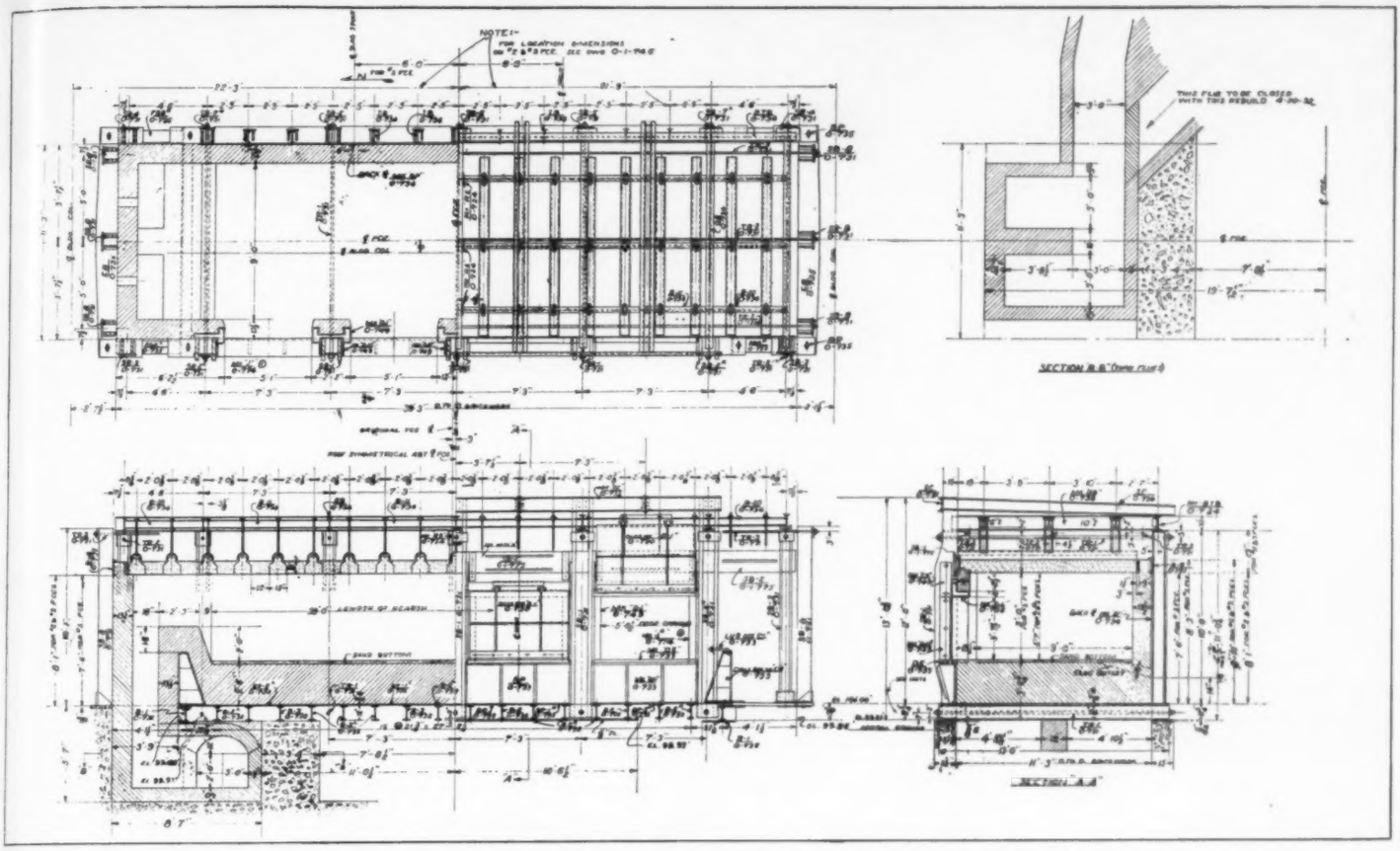


Figure 1—Conventional regenerative heating type furnaces used on 84″ mill of the Lukens Steel Company.

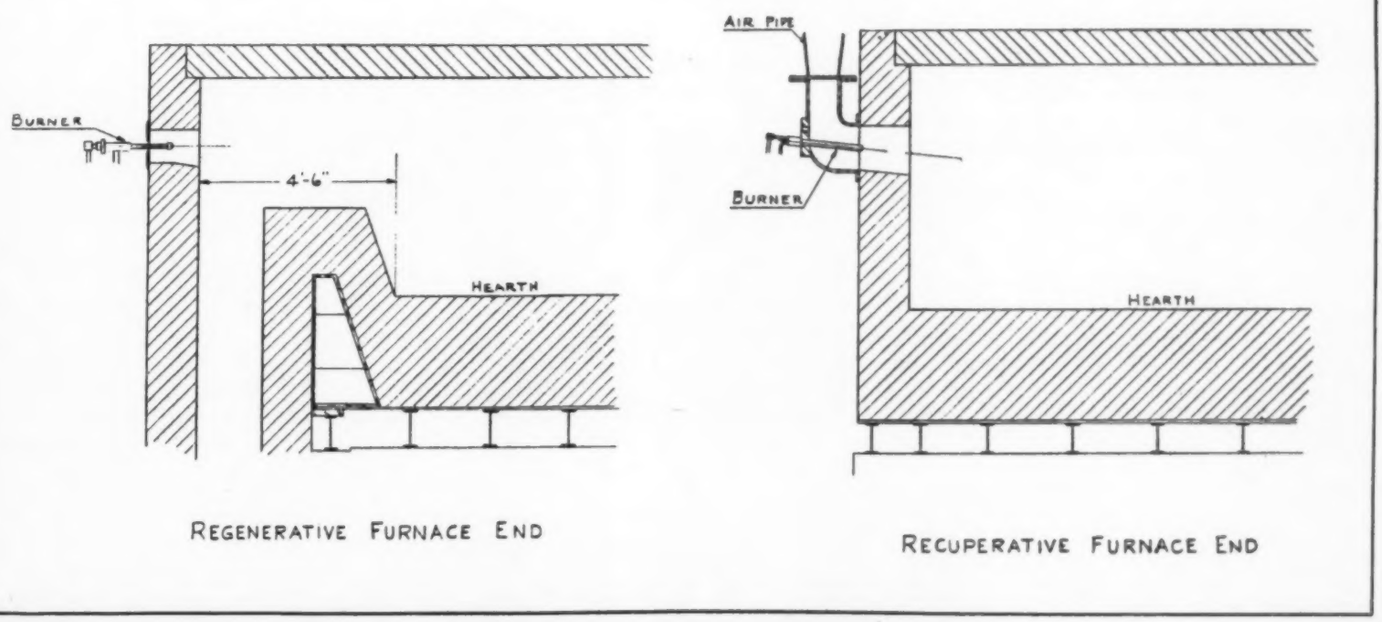
THE CONTROL SYSTEM

The furnace is under complete automatic control, Fig. 3. The control system may be considered under three separate headings although each of these is dependent upon the others for its proper performance.

The furnace pressure is maintained by an indicating Air-O-line controller. The pressure is measured at a point between the center doors and about one foot above the hearth through a 2″ pipe which is led under the furnace to the control board and the instrument. To compensate for changes in temperature along the piping, a second pipe is laid parallel to the first but is open-ended at the furnace. These pipes operate two bells in the instrument which is equipped with a pointer and calibrated scale with a range of $-0.1''$ to $+0.1''$ H_2O. A change of $1/100''$ in pressure produces a pointer deflection of $\frac{1}{2}''$.

The instrument controls a piston pilot which in turn controls a pneumatic piston operating the stack damper on the top of the stack. In order to maintain equal closeness of control regardless of the furnace load, the stack damper must be moved in much smaller increments when it is near the closed position, and in larger steps at the other extreme of its travel. A cam in the piston pilot produces just such a condition and pressure

Figure 2—Comparison of the old and new furnace ends. The new furnace went into operation early this year.



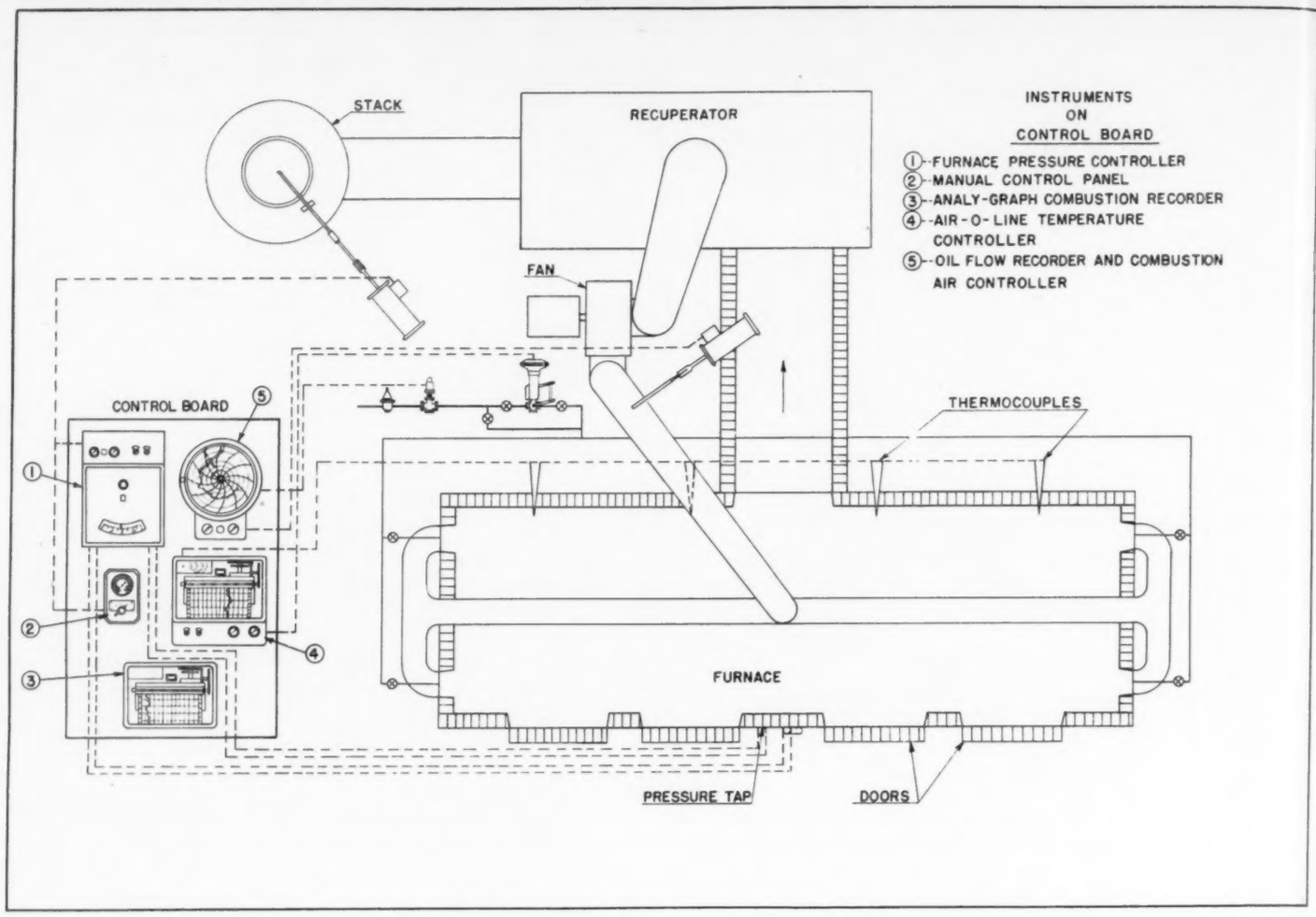


Figure 3—This shows the automatic control. This control is under separate headings but each is still dependent upon the other.

is controlled within three thousandths of an inch at all loads.

The temperature in the furnace is measured by means of four thermocouples spaced along the back wall and connected in parallel to a potentiometer pyrometer controller, employing the Air-O-line system.

The four thermocouples serve to provide a reliable guide for the control of the furnace. A single couple would be affected mostly by the steel in its immediate vicinity and other parts of the furnace might well be overheated or underheated; but with this arrangement, all parts of the furnace are influencing the action of the temperature controller.

The pyrometer controls a diaphragm motor connected to a rotary plug valve in the oil line to all the burners,—Fig. 4. As the oil flow changes, the air flow is simultaneously adjusted by means of a semi-metered combustion control system, employing the oil flow meter on the furnace. This meter is equipped with a pneumatic system which produces a definite and linear change in controlled air pressure with uniform changes in oil flow. This pressure is then transmitted to a piston pilot similar to that used for the stack damper control. The piston, in turn, operates a circular bottom slide damper in the preheated air duct thus producing an opening of a given area in the air duct for each condition of oil flow.

The flow of air through an opening varies directly with the area of the opening and with the square root of the pressure drop. A damper such as this does not produce uniform changes in area with equal steps of the damper, and since the hot air fan is driven by a constant speed motor, the pressure ahead of the damper increases as the damper area is reduced. The valve motion must be modified for these two variables: i.e., non-uniform damper area characteristics and variable pressure drops, in order to maintain the relation of oil flow to air flow in accordance with predetermined rules.

Figure 4—View of the pyrometer that controls the diaphragm moto connected to a rotary plug valve in the oil line to all the burner

This is readily accomplished by the use of a suitable cam for the piston pilot which produces non-uniform piston motion for uniform changes in the pressure from the oil flow meter.

Changes in ratio are secured by means of a dial within the oil flow meter, which can be locked to avoid tampering by some disinterested party. The control instruments are mounted on a panel board conveniently located at the back of the furnace, Fig. 5.

CONTROLLING A SIDE DOOR HEATING FURNACE

In tackling a problem of furnace control such as this, many things must be taken into consideration. These factors may conveniently be divided into three groups: i.e., conditions within the furnace, conditions outside the furnace, and the selection of the control equipment.

Among the conditions within the furnace to be considered are:—

(A)—Means of temperature measurement.

How should the temperature in a furnace such as this be measured? Obviously, as the heating of the material within the furnace is to be controlled by an instrument, we must transmit to that instrument reliable information upon which the control can act. In such a furnace also, the temperature distribution is likely to be uneven, especially as the furnace is approaching peak material temperature ready for soaking.

(B)—The method of pressure measurement.

The selection of the point of measurement. It will obviously make a great deal of difference whether the pressure is measured at the hearth, at the roof, or at the stack.

(C)—The method of atmosphere measurement.

Should a complete continuous analysis be taken of the furnace atmosphere, or should infrequent orsat analysis be taken?

(D) The burner arrangement.

For necessary control of fuel, it is not simply necessary to install a control valve somewhere in the fuel line and hope that the single valve control will accomplish the results desired. Most burners are controlled by individual valves directly at the burner; however, they are not designed primarily with the idea of maintaining a common supply to all units.

Passing now to the conditions outside the furnace, we must consider:—

(A)—The temperature of the preheated air and its effect upon the control.

(B)—The temperature and nature of the oil; such as, viscosity, fire, and flash, etc.

(C)—The pressure of the steam and oil, and the variations therein.

(D)—The fan characteristics of the preheated air.

(E)—The stack characteristics.

(F)—The physical location of fans and dampers.

The selection of the equipment is a matter to be given considerable thought. One must consider:—

(a) Reliability; (b) Simplicity; (c) Accuracy; (d) Flexibility; (e) Maintenance required, and (f) Cost.

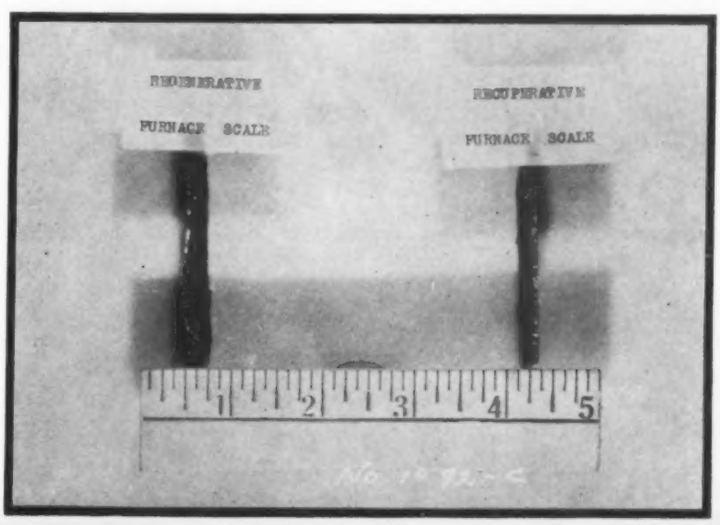
Figure 5—The control instruments mounted on a panel board located conveniently at the back of the furnace.

We place cost as the last item in this list because defects of the equipment in the other factors named may materially reduce the return on the investment. It is better to have a complete job without being wasteful than to attempt to be economical and have incomplete control.

In the consideration of these factors, we reached the conclusion that the furnace should be provided with complete automatic control including furnace pressure control, temperature control, and atmosphere control.

Pneumatic controls are used throughout, in spite of the general dislike which has existed for this type of material in the steel industry for many years. We passed this decision largely upon the simplicity, flexibility, and ease of maintenance of the equipment available.

Figure 6—Comparison of "furnace loss". The scale at the left is from a regenerative type furnace while that at the right is from a recuperative type.



Instrument companies have progressed a long way from the early days when most of us had our first experience with air control. The accuracy of equipment of this type can now be depended on; the reliability is, we believe, superior; and the maintenance required is comparatively small.

While the operation of the furnace is new to the mill heaters, we have been able to reduce our oil consumption consistently until we are now 8 gallons per ton of mill product below the conventional regenerative furnaces in this mill, and we expect to do still better.

This performance we attribute equally to recuperators and control. In addition, we have been able to substantially reduce metallic furnace losses due to scale, which is almost entirely a function of furnace control.

Scaling of metals is the result of oxidation of some metallic element or elements in a metal alloy by a gas or gases present in the furnace atmosphere.

It has been stated that air, water vapor, and CO_2 when present in the furnace atmosphere are active oxidizing agents in the order mentioned. This being the case, it can be assumed that absence of free oxygen and a high carbon dioxide content in the furnace gases is most to be desired.

In actual practice we found that it was neither economical or desirable to maintain a "neutral" or "reducing" atmosphere in the furnace as measured by flue gas analysis leaving the furnace. I am using these terms as a combustion engineer uses them.

With bunker "C" oil as the fuel, the most economical CO_2 content seems to be from 11% to 13%; this provides the best fuel rate per furnace hour no noticeable increase in scale thickness.

While it is desirable to limit scale thickness, it is not necessary to eliminate it entirely, but rather to govern its thickness and density, so that a thin heavy scale which readily breaks away from the ingot is obtained instead of a thick porous scale which has a tendency to cling to the ingot or slab.—Fig. 6. Regarding this scale weight or as it is termed "furnace loss", repeated tests have shown it to be at least 25% less by the controlled recuperative furnace, or about 1 per cent increase in metallic yield from the ingots heated in this furnace. —Fig. 7.

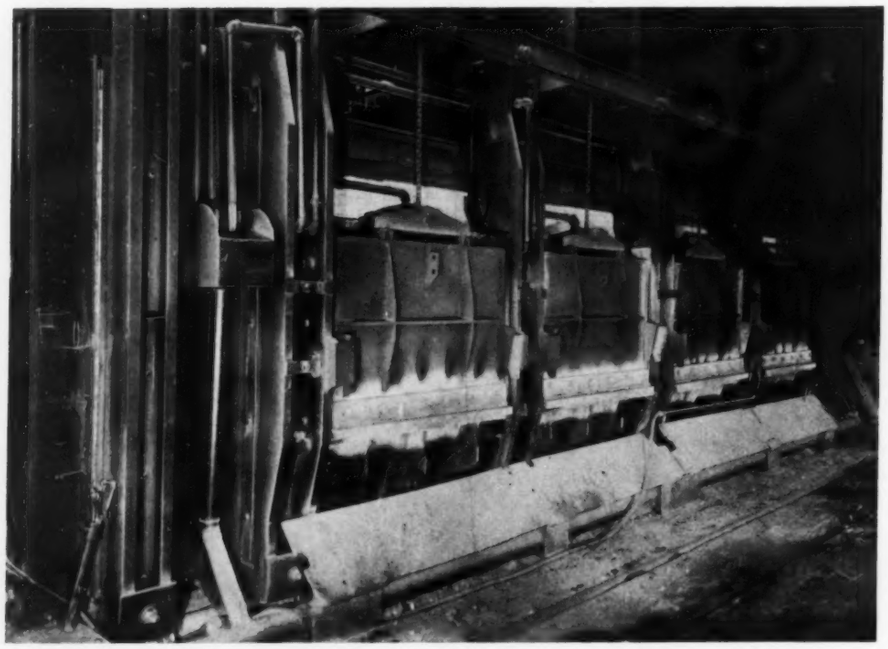


Figure 7—Closeup of a recuperative type furnace. Repeated tests have shown it to have 25% less "furnace loss".

During the week ending January 30th, the mill rolled 1532 tons which was heated in three furnaces, one being the recuperative furnace. We made a preliminary study of the defects by furnaces including both open hearth and mill defects with the result that of the 5.67% total defects, the recuperative furnace produced 16% less defects than the regenerative furnaces.

We do not think that we have yet attained our goal, but we have effected economies both in fuel and mill yield, we have given the steel better "treatment" during the heating process, and at the same time made the heater's job a lot more pleasant.

FURNACE ATMOSPHERE

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Bethlehem Steel Company
SPARROWS POINT, MD.

Presented before the Philadelphia District Section, A. I. & S. E., February 6, 1937

▲ THE purpose of this paper is to summarize and present data that can be readily used in the solving of furnace atmosphere problems. Since the equilibrium points of combinations of the gases and metals revolve about many physical, chemical, and metallurgical conditions, many of which are unknown or not universally adopted as factual; and as the average manufacturer is primarily interested in designing or selecting equipment to do his special job, the scope of this paper will be confined to an engineering approach to the subject. Furthermore, since many metals are involved in the subject, the writer has chosen to confine this paper to the treatment of carbon steels, because these steels are by far the largest volume of work treated with special atmospheres.

The subject is therefore readily divided into two parts; namely, (1) direct fuel fired furnaces where the combustion gases come in contact with the steel; and (2), indirect fuel fired furnaces where the steel is protected by containers. Electrically heated furnaces naturally fall in the latter classification.

The engineer who contemplates entering the furnace atmosphere realm will do well to thoroughly investigate his seemingly innocent problem before he becomes engulfed in the customer's rejections and shortly thereafter entangled in the bosses' temper.

Mr. C. O. Ralston states, "The iron oxygen system has not proved as simple as might be expected. In fact it is amazingly complex; although there are only three authenticated oxides of iron, they dissolve in each other in several series of solid solutions, so that the pure oxides are rarely found".

The reactions that form the three oxides of iron are as follows:

$$O_2 + 2F_e = 2F_eO$$
$$O_2 + 4F_eO = 2F_{e2}O_3$$
$$F_eO + F_{e2}O_3 = F_eO - F_{e2}O_3 = F_{e3}O_4$$

Furnace atmospheres in the direct fired furnaces are said to be either "reducing" or "oxidizing". In the interest of fuel economy, both of these conditions, in practice, are actually oxidizing, particularly at high temperatures. The "reducing" atmosphere is said to contain combustible gases, whereas, the "oxidizing" atmosphere is made by complete combustion with excess oxygen.

In order to maintain sufficient flame temperature and a reducing atmosphere, a great amount of fuel would have to be wasted in the ordinary direct fuel fired furnace applications. The practical solution of this difficulty has been solved by the use of gases that lend themselves readily to carbon precipitation. In this case fine free carbon must be precipitated in the burning of the fuel. This carbon creates a protective atmosphere close to the sheet and prevents excessive oxidation.

The carbon atmosphere can be created in many ways, the most common of which are as follows:

1. The diffusion flame gas burner.

This type of burner keeps a rich gas blanket near the steel and precipitates carbon in addition. The burner must be very accurately designed to fit the combustion space so that the gases will be burned before the flame changes direction or the air strata will come in contact and scale the work.

2. Premix gas burners in combination with carbon gas burners or mechanical oil burners.

In this combination, the object is to precipitate carbon on the steel by the use of carbon burners, while the other burners furnish the required heat. This is the most successful combination so far developed.

3. Oil Burners.

Oil makes a very good carbon flame. However, due to atomizing limitations, it is not as reliable as the gas fuels, although there are many installations operating to good advantage. If there is a choice, gas is to be preferred.

4. Producer Gas.

This gas makes a very good carbon flame but is difficult to control at the furnace, because of its mechanical limitations. It is the least desirable of all the fuels.

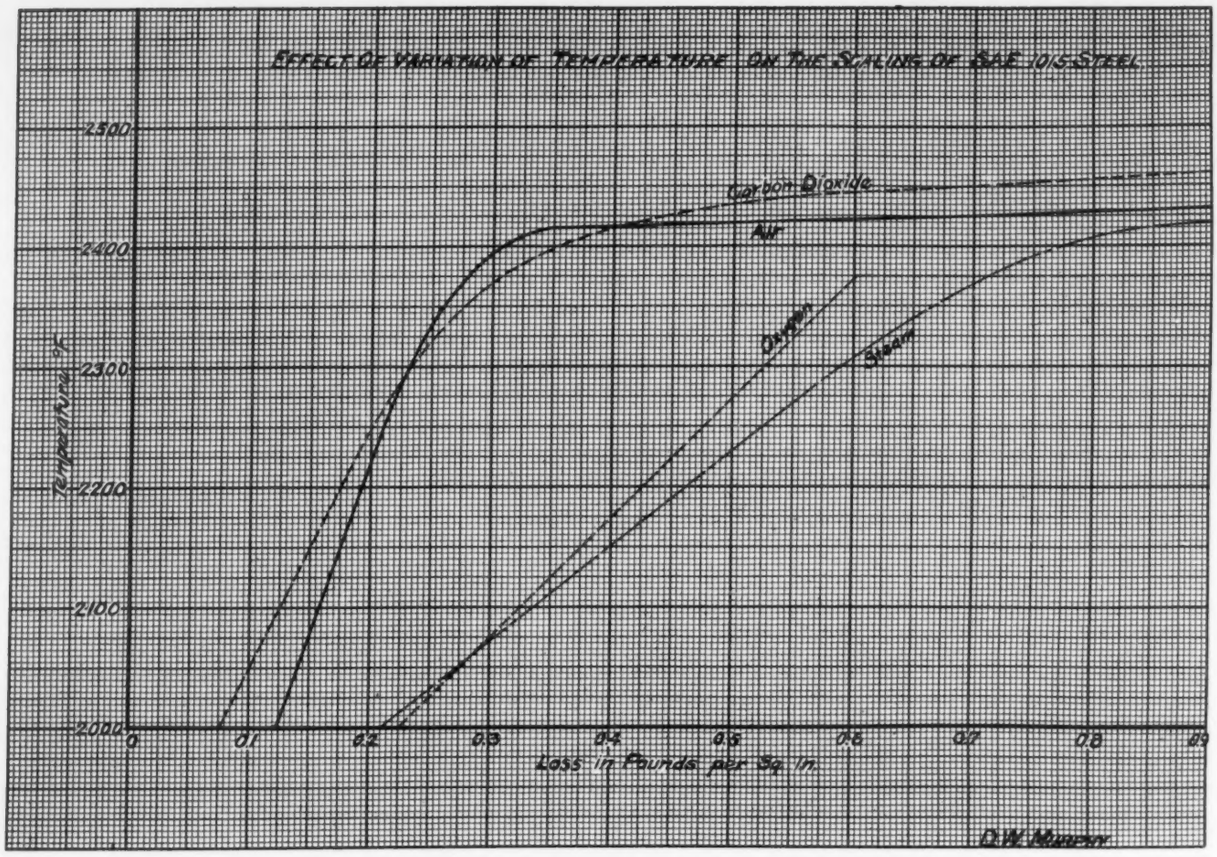
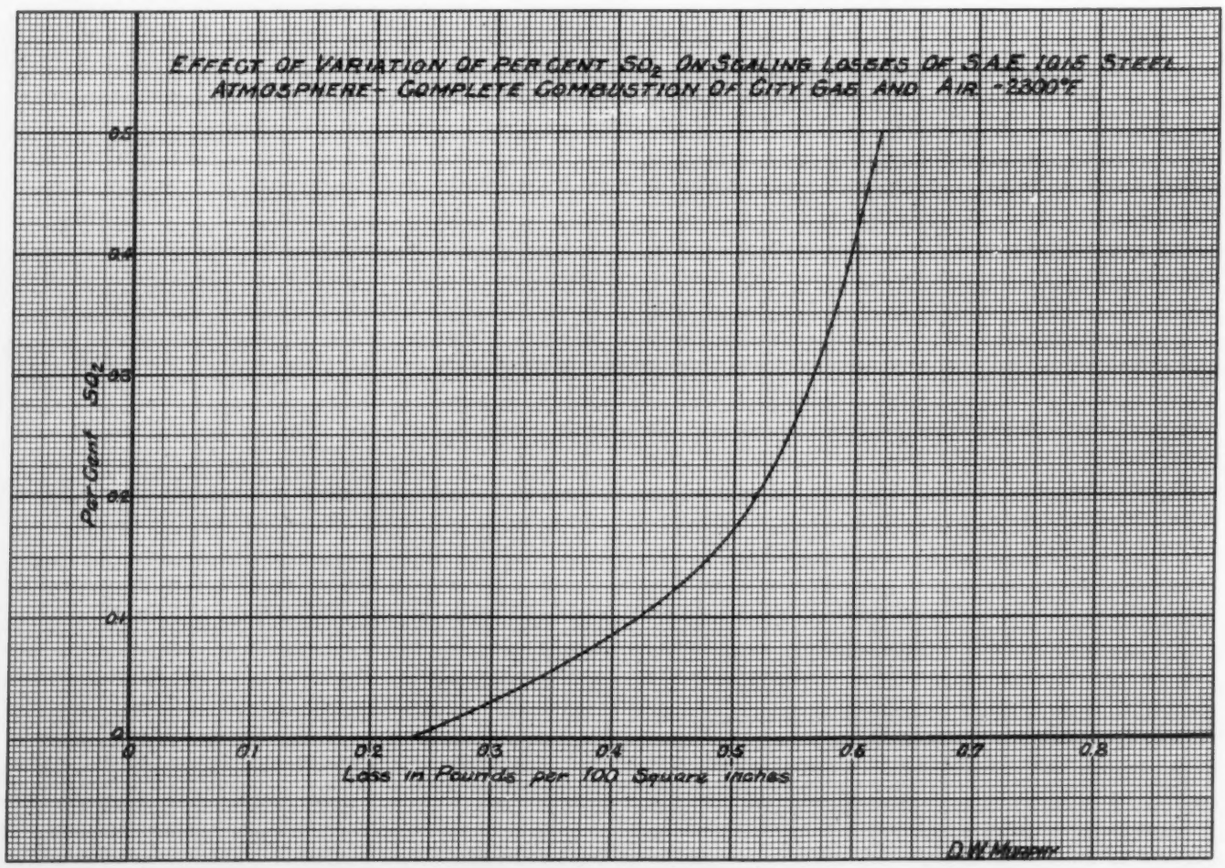


Fig. 1—Effect of variation of temperature on the scaling of S. A. E. 1015 steel.

Mixed coke oven and blast furnace gas below 300 Btu. per cu. ft. will not precipitate carbon unless preheated. This condition also exists in other pure gas combinations of similar low Btu. content.

Theoretically reducing atmospheres, particularly for bright annealing, are considerably more complicated in theory, and, therefore, much harder to duplicate

Fig. 2—Effect of variation of percent SO_2 on scaling losses of S. A. E. 1015 steel. Atmosphere—Complete combustion of City Gas and Air.—2300 F.



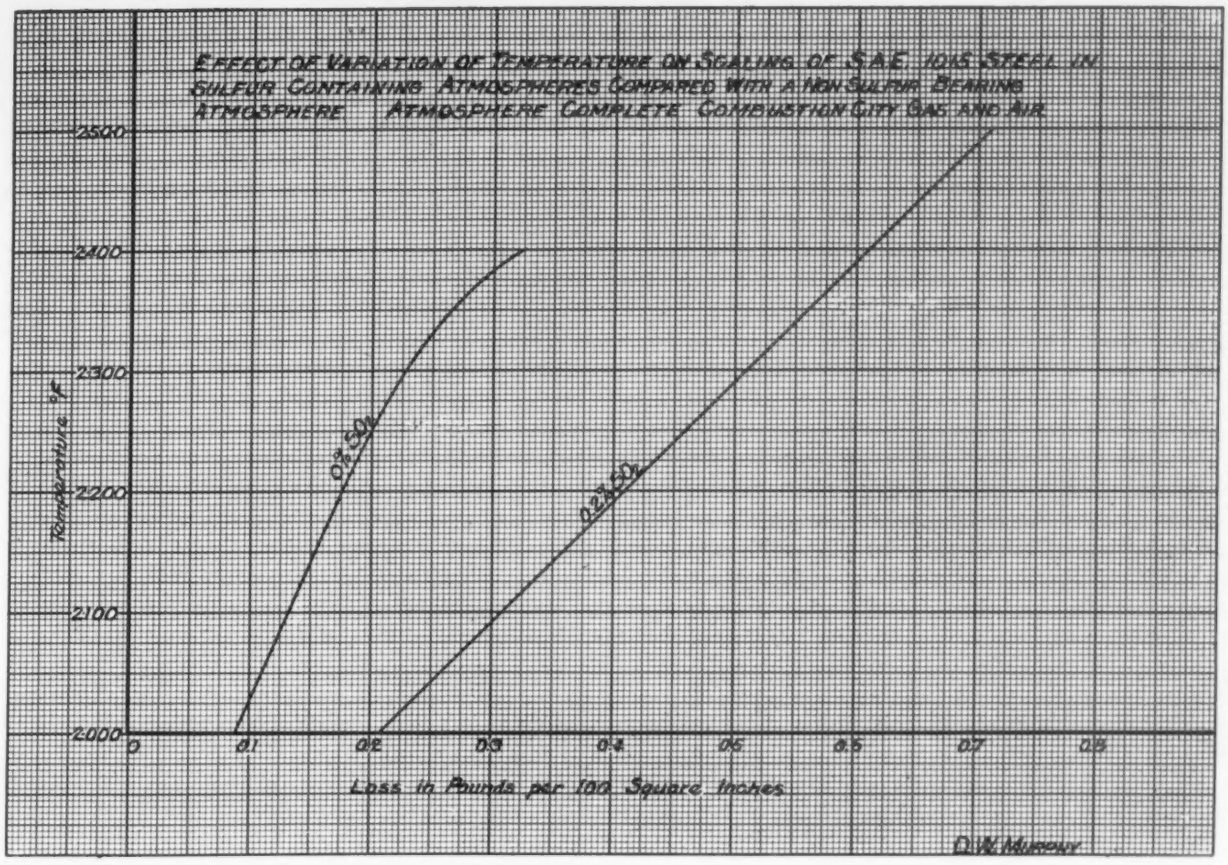
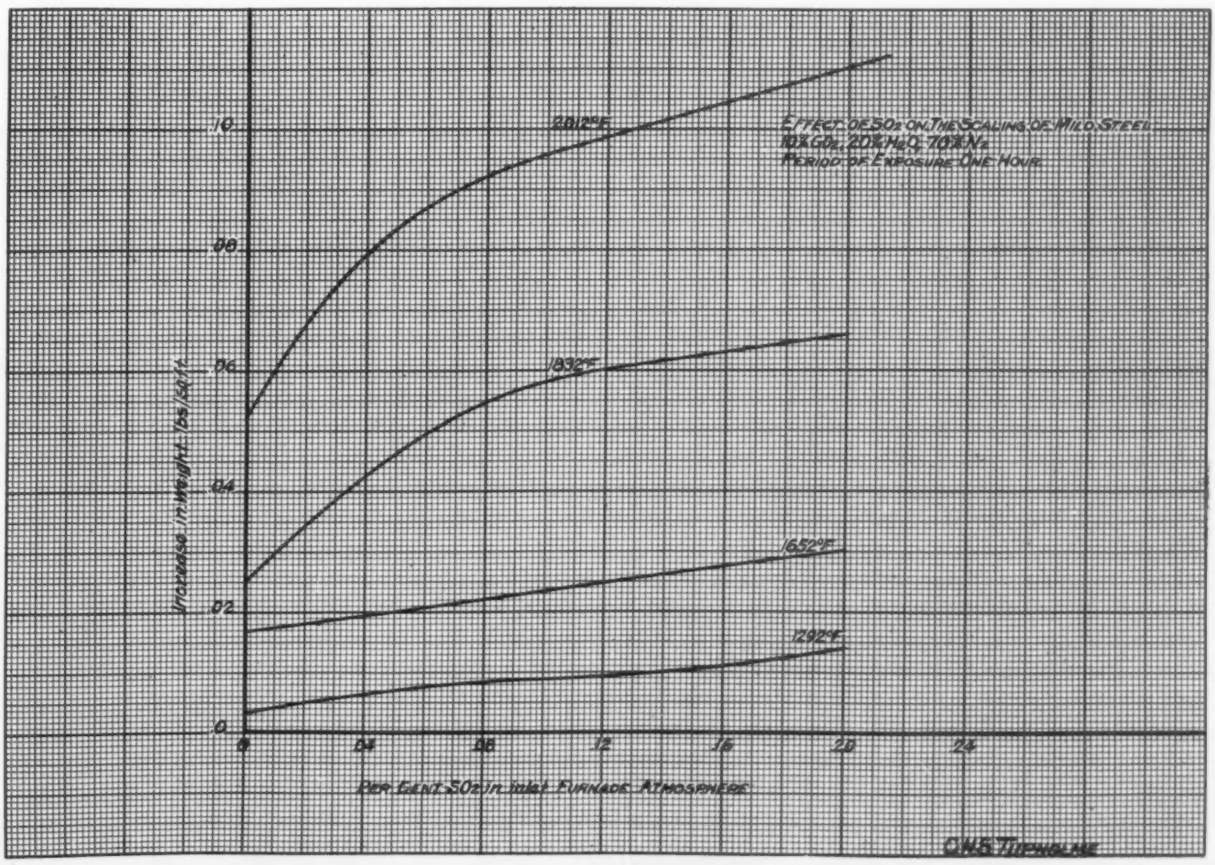


Fig. 3—Effect of variation of temperature on scaling of S. A. E. 1015 steel in sulphur containing atmosphere compared with a Non-Sulfur bearing atmosphere. Atmosphere complete combustion City Gas and Air.

Fig. 4—Effect of SO_2 on the scaling of mild steel. 10% CO_2, 20% H_2O, 70% N_2. Period of exposure—One hour.

in practice than the ordinary carbon precipitated atmospheres.

The relative oxidizing rates of steam, oxygen, air and carbon dioxide on steel are shown on Figure 1. Figures 2, 3, and 4 show the actions of sulphur in scaling steel. These are the gases that must be eliminated or compensated for before any atmosphere can



become truly reducing. Sulphur, water vapor, and oxygen can be eliminated easily, whereas, carbon dioxide is usually rendered neutral by mixing it with other reducing gases, mainly carbon monoxide.

Sulphur is usually in the form of H_2S and can be taken out by passing the gas through activated iron oxide. However, this will not take out organic sulphur. Organic sulphur can be removed after the gas is cracked or reformed. The heating cracks the organic sulphur and it reforms into H_2S and SO_2 which can be taken out by passing the gas again through activated iron oxide.

A formula for the designing of activated iron oxide towers for sulphur removal is as follows:

$$A = \frac{G \times S}{3000 \times (D + C)}$$

A = Area of any one section in Sq. Ft.
G = C. Ft. gas per hour at 60° F. and 30″ Hg.
C = Constant 4 for 2 box series.
= " 8 for 3 box series.
= " 10 for 4 box series.
S = 480 for 200 grains of sulphur for 100 cu. ft. gas
= 500 for 300 " " " " " " " "
= 525 for 400 " " " " " " " "
D = Total depth of all layers in ft.

Water vapor can best be taken out of a gas by cooling it in a heat interchanger using cold water, and then refrigerating the gas. If further reduction of water vapor is desired, it may be passed through aluminum oxide drying towers, silica jel, etc.

Free oxygen can be eliminated by cracking or reforming the gas above the ignition point of any one of its components.

The effect of incomplete combustion on scaling is shown by Figure 5. The reducing range is between zero and two parts of air to one of gas. This is therefore the non-scaling range for the air to gas ratio of this particular gas.

Reducing atmosphere for bright annealing are made chiefly by two methods; namely, (1), pyrolytic heating of the gas in closed iron containers to a higher temperature than that at which it is to be used; and (2), partially burning the gas with just enough air to produce the desired percentages of constituents. The former produces a gas that does not decarburize, whereas, the gas produced by the latter method does, because of its high carbon dioxide content which should be taken out before treating high carbon steels.

The pyrolisis or cracking of a gas at a desired temperature can best be done in an iron tube filled with coarse iron lathe-turnings. It is preferable to introduce or mix steam with the gas before it enters into the cracking tube. The steam is added to absorb the free carbon produced by cracking methane. The reactions are: $CH_4 \rightleftarrows 2H_2 + C$ and $H_2O + C \rightleftarrows Co + H_2$.

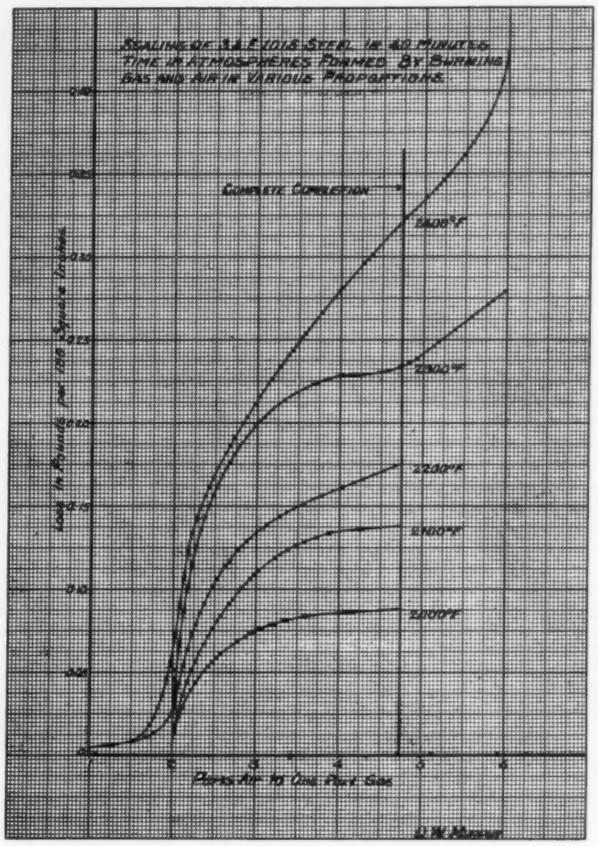
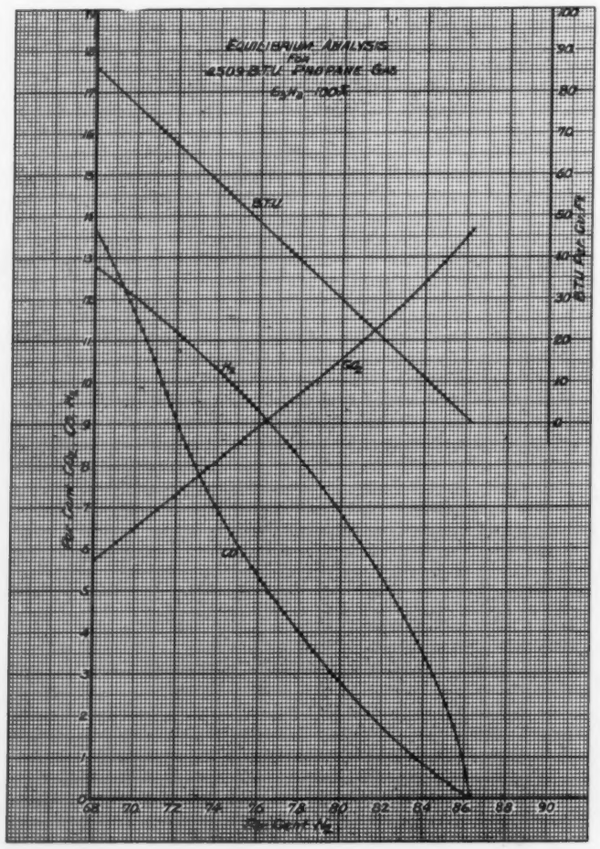

Scaling of S.A.E. 1015 Steel in 40 minutes time in atmospheres formed by burning gas and air in various proportions.
Complete Combustion
2400°F
2300°F
2200°F
2100°F
2000°F
Parts Air to One Part Gas

Figure 5—Scaling of S.A.E. 1015 steel in 40 minutes time in atmospheres formed by burning gas and air in various proportions.

Figure 6—Equilibrium analysis for 2509 B.T.U. propane gas. C_3H_8—100%.



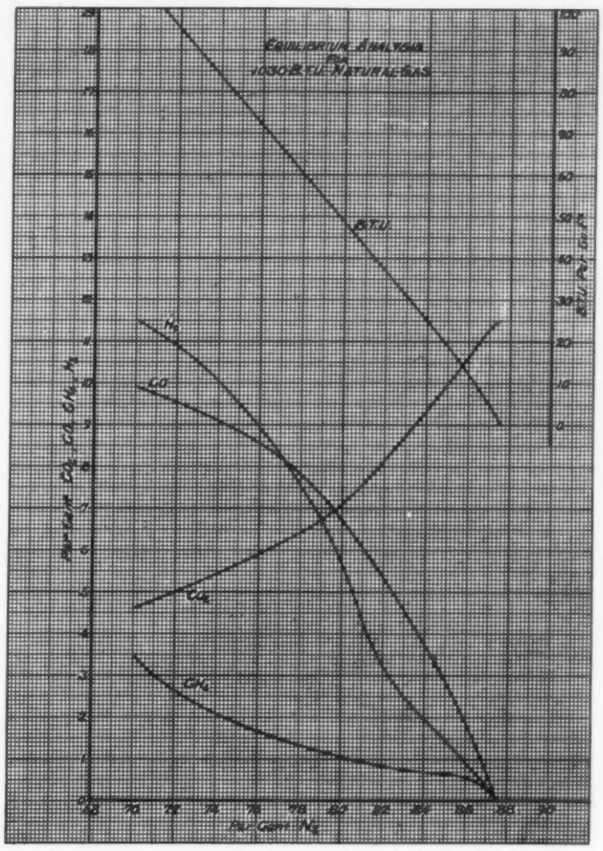


Figure 7—Equilibrium analysis for 1030 B.T.U. natural gas.

The temperature of the cracking unit should be higher than the temperature of the steel that is treated. Because of the life of the iron tube, temperatures of 1500° F. or over should not be considered, unless alloy tubes are used. The alloy tube is not as effective as the steel tube.

Since the pyrolisis of methane in iron containers is a surface phenomenon, the rate of this change is therefore proportional to the time of contact. Mr. F. Heathcoat derives a formula for this condition using tubes filled with lathe-turnings, as follows:

$$L = 1.75 \frac{Q}{D3}$$

where L = Length in feet of preheating tube.
Q = Maximum gas rate in cu. ft. per hour.
D = Internal diameter of tube in inches.

Duplicate tubes are necessary because the lathe-turnings should be pushed out and cleaned every 24 hours. Very little carbon is produced by this method. This carbon can be filtered or washed from the gas if necessary.

The cracked gas is easily explosive with the proper air mixtures and should be handled with due consideration and respect. Therefore, its use is limited to the operations, where at the beginning of the atmosphere gas treating cycle, the furnace or steel is above the ignition temperature of the gas or where sufficient purging time can be allowed before heating takes place.

The analysis of a 300 Btu. mixed coke oven and blast furnace gas before and after cracking is as follows:

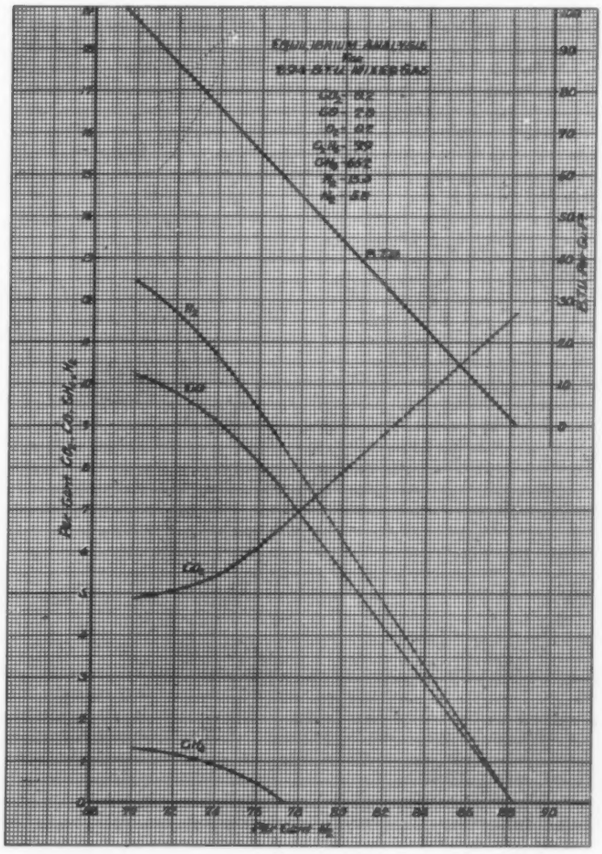
	CO_2	O_2	I11	CO	CH_4	H_2	N_2
Before Cracking	6.6	0.4	2.0	18.4	14.5	24.7	33.4
After Cracking	8.1	0.0	1.6	16.9	11.3	25.9	36.2

The above gas, before cracking, carboned and blued the steel, whereas, the cracked gas gave bright work. Care should be taken to direct the entering gas stream away from the work, otherwise some carbon will be deposited before pyrolisis takes place.

The partial burning of gases for special atmospheres is best accomplished in machines manufactured for this specific purpose, of which many types are on the market today. The machines are usually combined into a unit comprising, in most cases the following parts:

1. Air-gas ratio premixer and burner.
2. Combustion chamber and catalyzer.
3. Primary cooler and moisture eliminator.
   (a)—Gas is washed with cold water.
   (b)—Gas is cooled by cold water heat interchanger.
4. Secondary moisture eliminator.
   (a)—Refrigeration.
   (b)—Activated aluminum oxide. ($A1_2 O_3$).
   (c)—Silica jel.

Figure 8—Equilibrium analysis for 894 B.T.U. mixed gas.



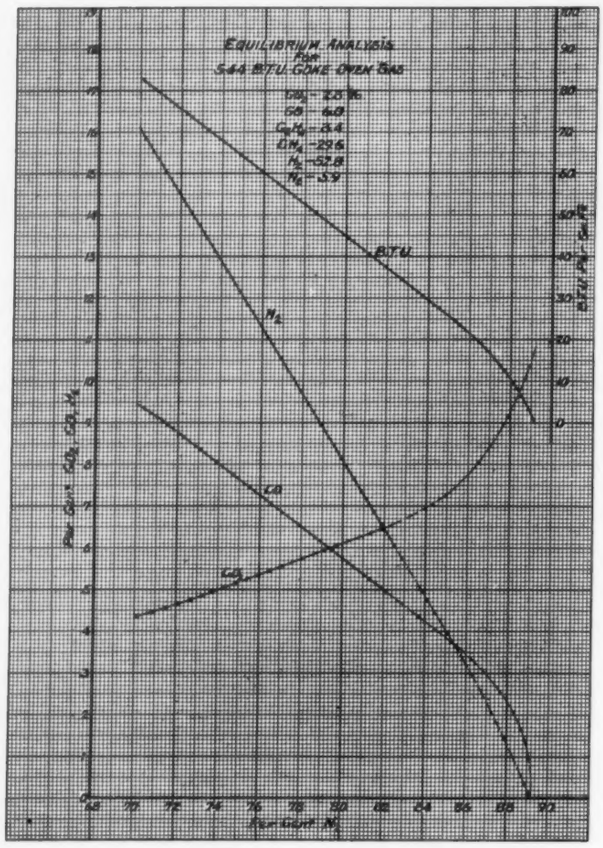


Figure 9—Equilibrium analysis for 544 B.T.U. coke oven gas.

The resultant gas from these machines is free from carbon and is non-explosive if below 50 Btu. per cu. ft.

Figures 6, 7, 8, 9, 10, and 11 show chemical analyses of partially burned 2509 Btu. propane, 1030 Btu. natural gas, 894 Btu. mixed natural and city gas, 544 Btu. Coke Oven Gas, 315 Btu. mixed blast furnace and coke oven gas, and 286 Btu. mixed blast furnace and coke oven gas respectively.

A list of the reactions between the atmosphere gases, iron and cementite (Fe_3C) are as follows:

No Reaction

$N_2 + Fe =$
$H_2 + Fe =$
$N_2 + Fe_3C =$
$CO + Fe_3C =$

Oxidizing to the Right

$O_2 + 2Fe \rightleftarrows 2FeO$
$CO_2 + Fe \rightleftarrows FeO + CO$
$H_2O + Fe \rightleftarrows FeO + H_2$

Carburizing to the Right

$CH_4 + 3Fe \rightleftarrows Fe_3C + H_2$
$2CO + 3Fe \rightleftarrows Fe_3C + CO_2$

Decarburizing to the Right

$2H_2 + Fe_3C \rightleftarrows 3Fe + CH_4$
$O_2 + 2Fe_3C \rightleftarrows 6Fe + 2CO$
$CO_2 + Fe_3C \rightleftarrows 3Fe + 2CO$

It is generally accepted that a large CO_2/CO ratio will produce scaling and decarburizing, and that a small ratio will produce the reverse. Likewise, the

Figure 10—Equilibrium analysis for 315 B.T.U. mixed gas.

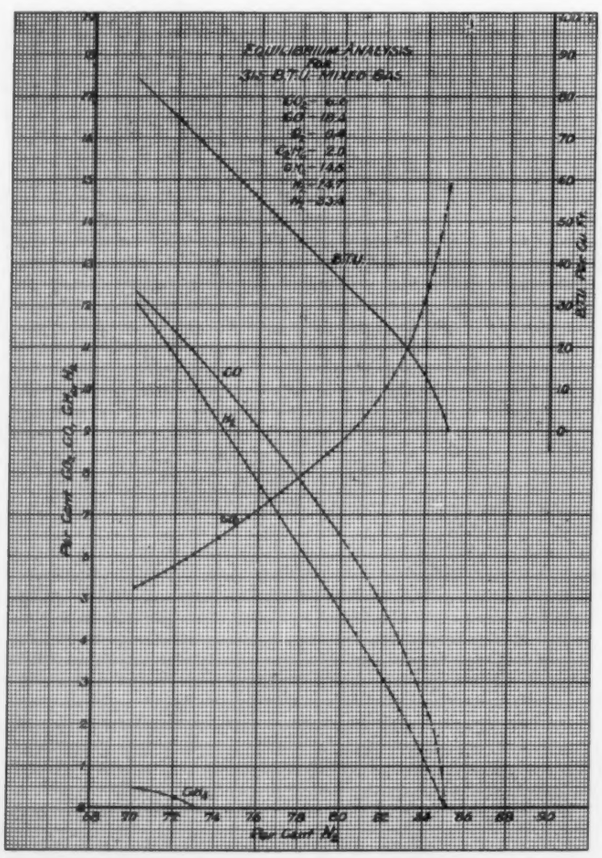
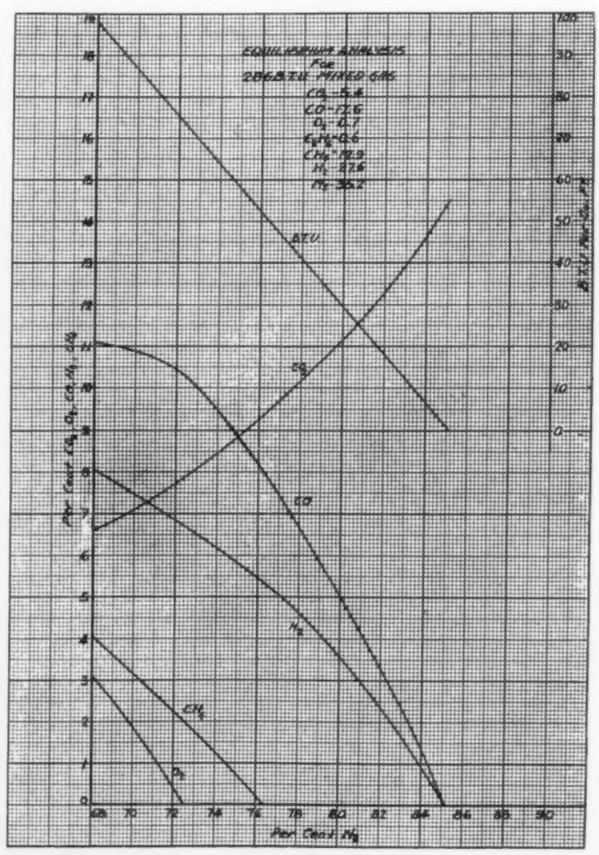


Figure 11—Equilibrium analysis for 286 B.T.U. mixed gas.



ratio CH_4/H_2, if large, will cause carburization, and if small decarburization will result. Similarly, the ratio of H_2O/H_2 will produce scale if large, and if small the action will be reversed. The nature of these relations to temperature are shown in Figure 12.

Most practices have proven nitrogen to be inert except in the nascent condition. Under certain conditions it may be decarburizing in the presence of water vapor. However, in most cases, this reaction is relatively unimportant.

Figure 13, shows the equilibrium for the system Fe, FeO, H_2, and H_2O. The importance of the elimination of water vapor in placing the gas on the reducing side can be readily seen. The percent of water vapor in partially burned saturated gases is shown in Figure 14. This shows the relative importance of refrigerating the gas, or equivalent, for moisture elimination. The use of this chart and Figure 13 shows whether the relation of H_2O to H_2 is on the reducing side or not.

Figure 15 gives the equilibrium for the system Fe, FeO, CO, and CO_2. Here, carbon dioxide is the enemy of reducing atmospheres.

The engineer usually finds himself confronted by four problems in heat treating with reducing atmospheres, briefly these are:

1. Maintaining a bright surface.
2. Reducing an oxide already formed to the free metallic state, commonly called bright annealing.
3. Maintaining the carbon content of the steel without decarburization in combination with either of the above two conditions.
4. Adding to the carbon content of the steel or carburizing.

The relative case with which the above treatments can be performed are in the order given. The gas for Item 1, maintaining a bright surface, can be a 50 Btu.

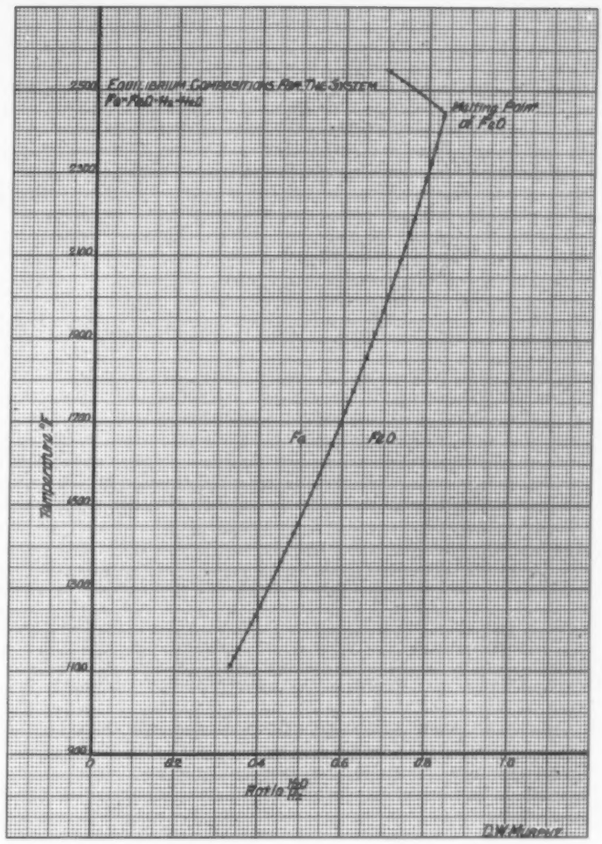
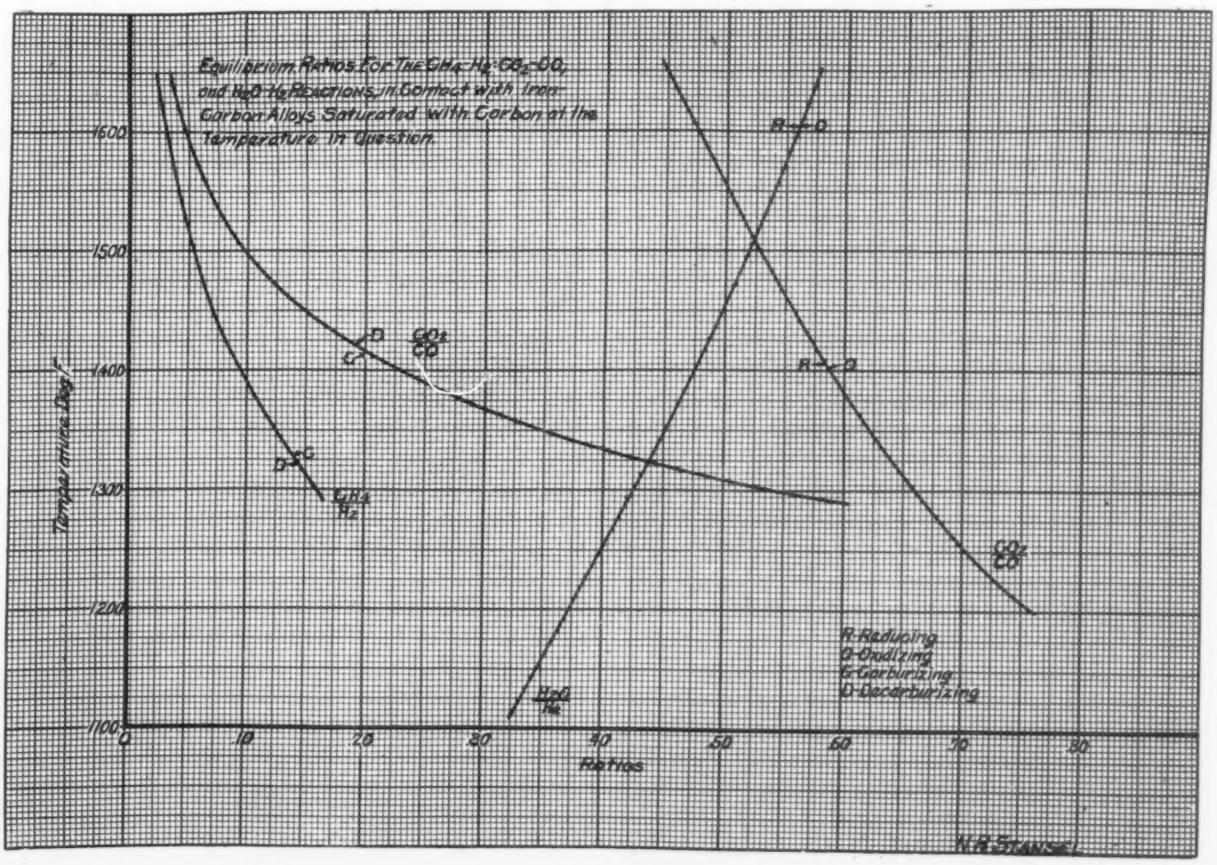


Figure 13—Equilibrium compositions for the system Fe-FeO-H2-H2O.

Figure 12—Equilibrium ratios for the CH_4-H_2:CO_2-CO; and H_2O-H_2 reactions, in contact with iron. Carbon alloys saturated with carbon at the temperature in question.



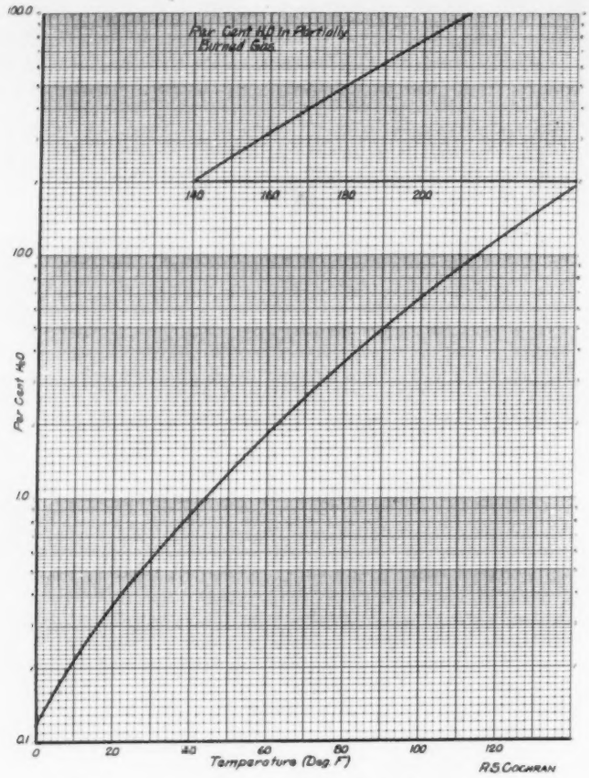
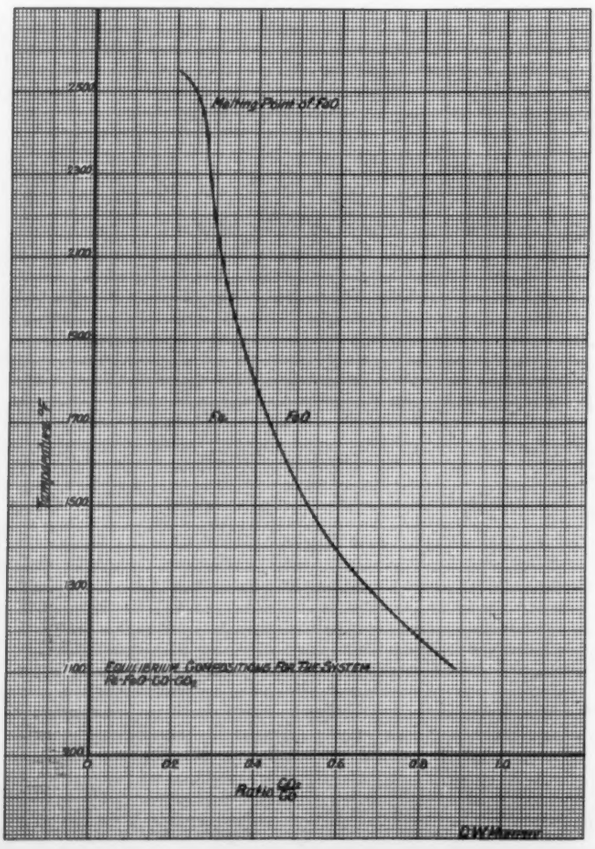


Figure 14—Per Cent H_2O in partially burned gas.

partially burned gas, whereas, a richer gas is required by Items 2 and 3. Atmosphere gases for Item 3, in addition to the requirements of Item 1 and 2, should be higher in methane content and lower in carbon dioxide and hydrogen to prevent decarburizing. Care is necessary here to produce a neutral gas atmosphere, otherwise carburization will result if the gas is too rich. Item 4, carburizing, is best done by precipitating carbon on the steel during the heating up cycle by means of a high hydro-carbon gas, after which a gas containing carbon dioxide is introduced. At tempera-

Figure 15—Equilibrium compositions for the system Fe-FeO-CO-CO_2.



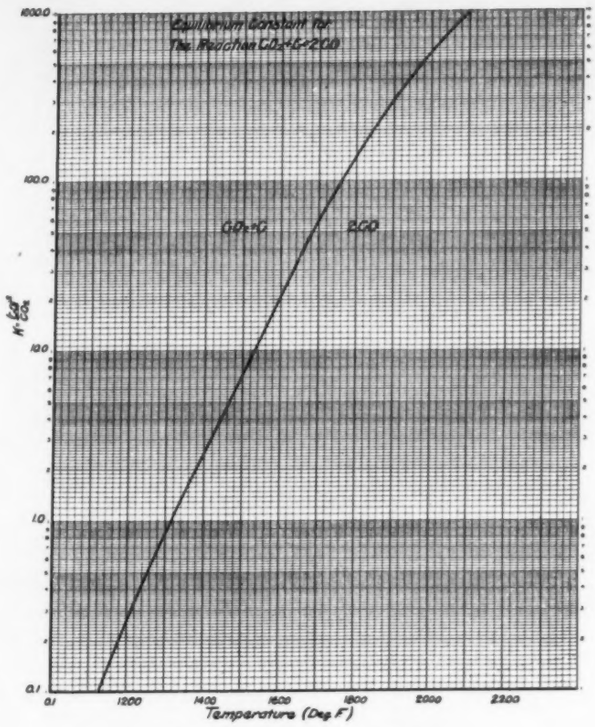


Figure 16—Equilibrium constant for the reaction $CO_2 \rightleftarrows C = 2CO$.

tures above 1600° F. the reaction $C + CO_2 = 2CO$ is relatively rapid. The carbon is changed to carbon monoxide which with the aid of the available methane produces carburization. The water vapor content of the gases for the above four items should be minimized, and particularly, in Item 4, carburizing should be eliminated.

Figure 16, shows the variation with temperature of the equilibrium constant "K" for the reaction $CO_2 + C = 2CO$. For a gas containing 10% Co and 10% CO_2 "K" = 10.0. From the chart, carbon precipitation can be expected at temperatures below 1525° F.

Figure 17, the same conditions for the reaction $CH_4 = C + 2H_2$.

A very interesting reaction in the box annealing of sheets with hot mill scale is $Fe_3O_4 + 4Fe_3C = 15\ Fe + 4CO$. In this case the steel is decarburized, the scale is reduced to bright sponge iron, and carbon monoxide is liberated.

One of the greatest aids to the uniformity of results in bright annealing is the recirculation of the atmosphere gases. This recirculation is also a desirable feature in that it makes for greater uniformity of temperatures. Its widest application is in the treating of coiled strip and wire where the fans are located in the base, directing the gases up the center of the coils and down the outside. In other applications, the inside atmosphere can be recirculated by means of compressing the newly made gas to about 10 lb. per sq. in. and piping it to an inspirator which may be located at a vantage point over the top of the steel to be treated; thus about ten volumes of the old gas can be recirculated to one of the new gas entering.

Gases depositing carbon on the work without recirculation have been known to turn out perfectly bright surfaces with recirculation.

Recirculation establishes a uniformly thoroughly mixed gas in chemical equilibrium. The ultimate analysis of the gas is a function of the time, pressure, and temperature. The new gases, entering, are mixed

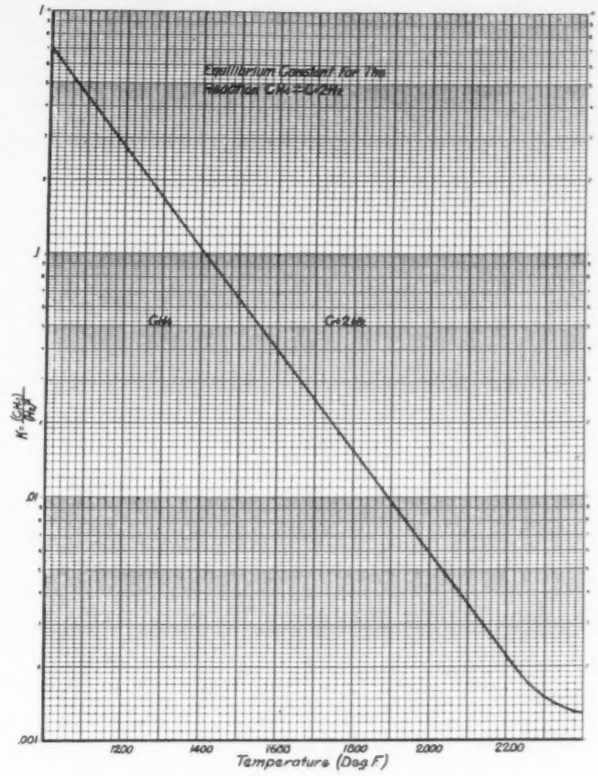


Figure 17—Equilibrium constant for the reaction $CH_2 \rightleftarrows C + 2H_2$.

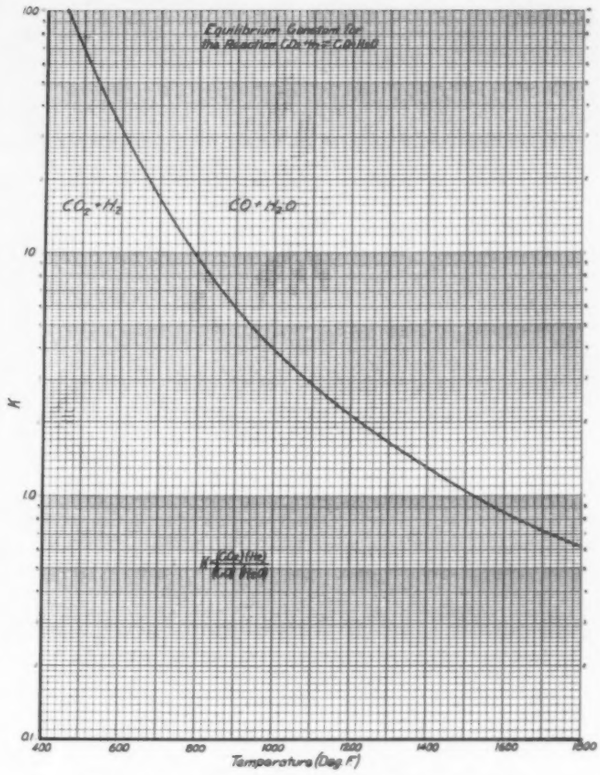


Figure 18—Equilibrium constant for the reaction $CO_2 + H_2 \rightleftarrows CO + H_2O$

and heated with the stabilized gases and set in motion. The iron surfaces of the charge act as a catalyzer and the time required for the following pyrolitic reactions to reach an equilibrium is shortened. These reactions are as follows:

CH_4	$2H_2$ C
CO_2 C	2CO
H_2O C	CO H_2
H_2 CO_2	CO H_2O

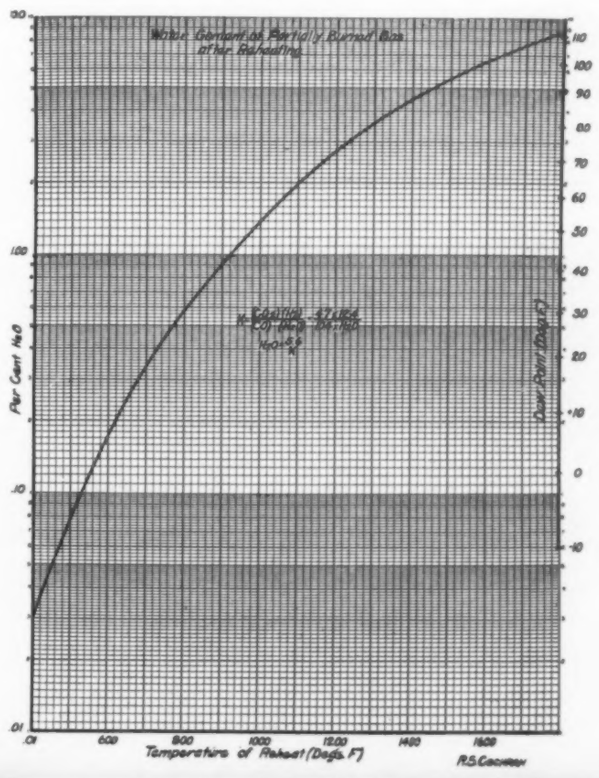
The desirability of keeping the water vapor content of the original gas low is therefore readily seen, otherwise the increase of H_2O, due to pyrolisis, will continue to build up until the gas becomes oxidizing, unless sufficient quantities of new gas are used.

Figure 18 gives the variation with the temperature of the equilibrium constant "K" for the reaction CO_2 H_2 COH_2O. Knowing the percentage of the CO_2, H_2, and Co., in the partially burned gas and taking "K" from the chart, the percentage of H_2O in the gas can be calculated when it has reached equilibrium. Figure 19 shows an application of chart 18 in which the percent of water vapor is plotted against the temperature for one particular partial burned atmosphere gas. The dew point of the gas at equilibrium is also shown. The build up of moisture due to the above reaction is apparent even though the gas entering is moisture free.

This brings up the subject of how much gas is necessary. Because of the many variables, the amount used will ultimately be determined by trial and error. However, 6 cu. ft. of sand seal per hour at 1" H_2O pressure is the usual practice for 50 Btu. partially burned gas. This is greater than the amount actually required to keep the inside atmosphere reducing. A very fine grade of sand is necessary. The seal should be about 5 inches in depth, giving a total seal of 10 inches when the cover is in position. It is good practice to stir up and mix the sand periodically to prevent the fine particles from settling to the bottom.

Considerable time and effort at present is being spent on the subject of furnace atmospheres, and equipment is being developed for most of the common applications. However, it is well to point out again, to those who pioneer and depart from the beaten path; that caution is to be commended and desired. The equilibrium of gases is infinitely variable, and for this reason every move should be preceded by sound experimentation before line production is attained.

Figure 19—Water content of partially burned gas after reheating.


Water Content of Partially Burned Gas after Reheating
Per Cent H2O
Dew Point (Deg F)
Temperature of Reheat (Degs. F)
R.S. Cochran

NEW TRUCK CONTROLLER

▲ AUTOMATIC Transportation Company, Chicago, Illinois, announce a basically new industrial truck controller.

The fundamental change that has been made in the design of this new controller is the motor type brush mounting which is rotary in action and not stationary as is the present conventional type industrial truck controller.

Also the stator segments are commutator type and are unit moulded into a permanent insulated base with no loose segments and no separate parts. This base is a stationary mounting and is also radically different than the conventional type now in use in that it does not rotate.

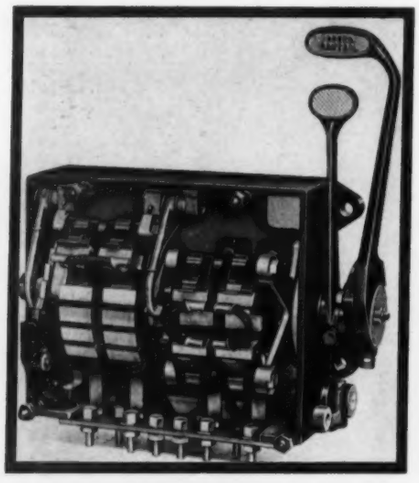
The main purpose of this new type of controller which was developed by "Automatic" engineers, is to meet the demand for reliable voltage control; smooth power performance and long electro mechanical life.

Another important feature is that the brushes are provided with a constant spring tension which is self-compensating and requires no manual adjustment. These are also constructed with exceptionally large contact areas which result in low voltage loss.

"Automatic" has adopted a trade-name which will be used and that is "Rotor-brush power flow control."

This controller will be the new standard motor control to be exclusively used on every "Automatic" industrial truck, tractor and crane.

Industrial truck controller with new motor type brush mounting.



NEW STRIP MILL

▲ MESTA Machine Company has booked a large order for a 44-inch continuous hot strip mill from the Inland Steel Company of Chicago.

The new business was said to consist of four roughing stands and a train of six four-high finishing stands. The Mesta plant at West Homestead is now working on the order.

Mesta also recently received new business from Jones & Laughlin Steel Corporation in the form of two skin mill stands to supplement tin plate capacity at Aliquippa. These new stands will receive strip from the new J. & L. continuous strip mill.

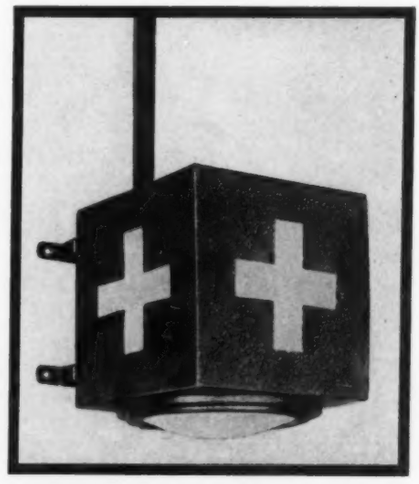
LANTERN FOR STRETCHER SIGNAL

▲ THIS lantern fills the need in modern steel and industrial plants for a completely distinctive signal to illuminate stretcher locations.

It is extremely valuable in case of accident. Valuable, too, in preventing accidents because it serves as a constant warning in showing the workman the stretcher he may use if careless.

The Lintern Stretcher Indicator Lantern is mounted on the wall above the stretcher with lens facing downward. Brightly illuminated green crosses measuring 4½" by 4½" on the three exposed sides of the unit give a clear signal regardless of the

Stretcher indicator lantern for modern steel and industrial plants.



distance or angle of the vision. The lantern body is constructed of 18 gauge steel, electrically welded, with white enamel interior. It is dust proof and weather proof.

The lenses are green ameroid, giving a brilliant green signal on three sides. A clear 6½" convex roundel is placed in the bottom for illumination of stretcher cabinet. Hinged door allows for easy light replacement.

Fittings are furnished with ½" conduit connection. Double wall bracket is of ⅛" x ¾" round edged hot roll steel.

The lamps are 25, 40, or 50 watt of Type A; 25 or 50 watt of Type P or G bulbs.

MILL TO BE NAMED FOR W. A. IRVIN

▲ CARNEGIE-Illinois Steel Corp. announced the new sheet and strip mill which will be constructed in the Monongahela River valley area will be named the Irvin Works in honor of William A. Irvin, president of the United States Steel Corp., of which Carnegie-Illinois is a subsidiary.

The company announced at the same time a substantial revision of the broad modernization program which was disclosed originally on January 15, 1937.

Instead of altering operations at the present location of the Clairton by-products coke and steel works, as stated then, the program now calls for the construction of the new plant to be given Mr. Irvin's name.

This plant will be built near the present Clairton operations, in the Camden District, on high ground overlooking the Monongahela River.

The company has purchased tracts totaling 600 acres for this purpose. The location lies in the angle formed by the Clairton-Dravosburg section of Pennsylvania Highway 837, on the east, and the paved New England Road on the south and southwest.

The revision of plans will obviate the necessity of dismantling present steel making facilities at Clairton Works. Instead, current operations there will be continued, and certain portions of the plant will be reconditioned, particularly the open hearth department, where ingot production will be increased by 18,000 tons a month through the firing up of three furnaces which have been down since 1932.

The new program does not alter the previously announced addition at Edgar Thomson Works, Braddock, of a 1,000,000-ton slabbing mill to supply semi-finished steel for the Irvin Works and other plants of the company.

The Union Railroad, also a subsidiary of United States Steel, traverses the eastern edge of the site, at the same level. Slabs from the Edgar Thomson mill will be conveyed to the Irvin Works by the Union Railroad.

H. G. McIlvried, recently brought from the Chicago District of Carnegie-Illinois as assistant to William C. Oberg, manager of operations, Pittsburgh District, will have charge of construction of the new plant.

It is expected the plant will be in production in about one year.

It was estimated that approximately 4,000 men will be employed at Irvin Works when it reaches capacity operation.

CONVEYOR HAS MANY NEW FEATURES

▲ MATHEWS Company, Elwood City, Pa., announces the development of shock-absorbing, resiliently mounted, roller conveyer.

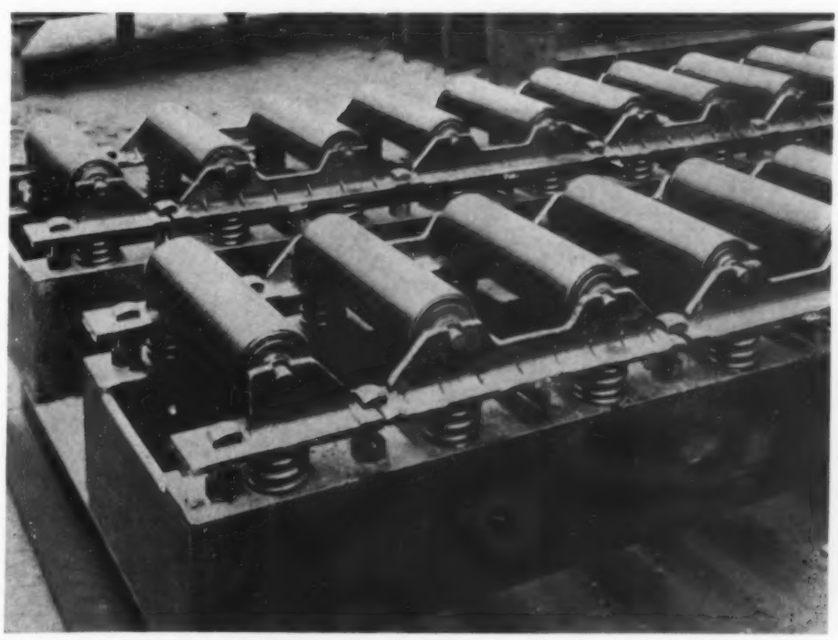
From actual tests and six months use in practive it has been conclusively proved that:

1. The resiliently mounted conveyer has minimized the abuse of the conveyers and has thereby very substantially reduced maintenance cost.
2. With resiliency in the roller mountings each roller carries its proportionate share of the load; bearing friction is reduced to normal. The result of this is that the co-efficient of friction used to calculate the effort required to move loads over roller conveyer has been reduced considerably.

In the handling of large coils of steel in the strip mills, the coils are generally loaded upon the conveyer by means of a crane. A common method for carrying coiled steel by crane is to use a magnet.

These magnets weigh about 10,000 pounds. Frequently, the crane operators are careless in loading the coils upon the conveyer and drop the coil plus the weight of the magnet on the conveyer with considerable impact.

Shock-absorbing, resiliently mounted roller conveyor.



Consider the 35,000 pound weight being dropped upon the conveyer rollers and the tremendous shock which the rollers must stand. Substantially the same condition is also found at the points where the coils are taken from the conveyers by the crane. The magnet is lowered down on top of the coil and the coil lifted.

Sometimes the conveyers are down in the pit and it is difficult for the crane operator to see whether the magnet has been centered over the coil, but after lifting the coil several feet the operator frequently discovers that the magnet has not been centered. He then lowers the coil and magnet until the coil again rests on the conveyer. The magnet is then centered and the coil is lifted free of the conveyer and carried to another part of the mill. In one steel mill where the above mentioned condition existed the rollers were very badly bent by the dropping of the heavy coils upon them. By actual test it has been found that heavy loads can be dropped upon the shock-absorbing, resiliently mounted conveyer and that the springs will absorb the shock which without the spring mountings would be injurious to the bearings of the rollers. There are many places where the resiliently mounted conveyer can be used to advantage besides those mentioned above.

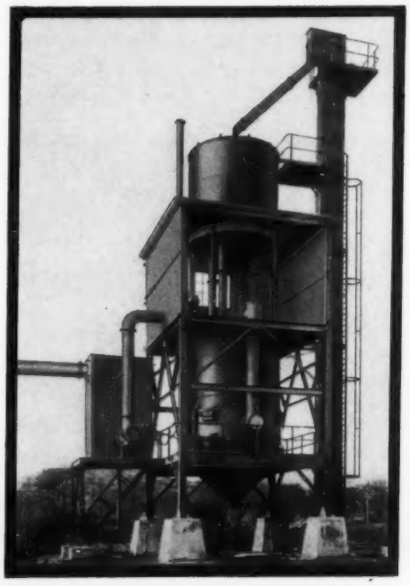
GAS GENERATOR

▲ THE Wellman Engineering Company, Cleveland, Ohio, announce that they have acquired the exclusive right and license under the U. S. Patents of Albert L. Galusha to manufacture and sell within and throughout the United States and its possessions the Galusha Gas Generator which produces a clean, high-grade, industrial gas from small anthracite coal, or coke-breeze, at a cost considerably below figures hitherto regarded as the minimum.

This generator provides a uniformly clean, and dependable gaseous fuel, since the fuels used do not yield tar, and is therefore particularly adapted to industrial heating operations in which the quality of the product requires care to avoid discoloration, sealing, pitting or spotting.

This gas generator will be marketed as the "Wellman-Galusha clean gas generator" in standard units with hearth diameters from 18 inches to 10 feet, the capacity of each unit being unusually high, varying of course with the grade and character of the fuel used.

Mr. Albert L. Galusha, the inventor, will be associated with The Wellman Engineering Company as



Gas generator for producing clean, high-grade, industrial gas.

Chief Engineer of the "Wellman-Galusha Gas Equipment", and will be located at the Company's eastern offices at 30 Church Street, New York City.

The addition of the Galusha clean gas generator for utilizing anthracite, and coke breeze fuel, to the well-known line of "Wellman Mechanical Gas Producers" which use bituminous coals as fuel, puts the Wellman Company in the position of being able to supply either *Clean Gas Generators* or *Hot Raw Gas* Producers, for the various industries where gaseous fuels are suitable.

TRUCK CONTROLLER

▲ Filling a long-felt need in industrial trucks, The Baker-Raulang Company, Cleveland, has announced a revolutionary new development known as their "NoPlug" Controller (Patent Applied For) which is now standard on all Baker trucks and which can also be installed on most Baker trucks already in service.

This new controller makes careful and correct operation of the truck compulsory by preventing "plugging" —starting from a dead stop in third speed or throwing the controller from full ahead to full reverse without stopping the motion of the truck. As the majority of all maintenance in connection with the operation of industrial trucks is directly traceable to plugging due to the great overloads and sudden reversals of stress imposed on the motor, axle, running gear, tires and battery, the far-reaching results of correct control may be easily realized. "NoPlug" prevents starting overloads by requiring the operator to start in first speed and to use the acceleration speeds which are provided. Instantaneous reversal is eliminated by making it necessary for the operator to bring the truck to almost a complete stop before power can be applied in the reverse direction. These inherent characteristics reduce both the maintenance costs and the time out for repairs and result in longer life for the truck and battery. The "NoPlug" feature is so designed that it cannot be removed and consequently full protection is assured for the life of the truck.

This new controller is of the metal drum, continuous torque type providing three speeds both forward and reverse and is interlocked with the brake through a magnetic blowout, mill-type contactor in such a manner that when the operator steps off the truck, the circuit is broken and the brake is set. The circuit can be made only by releasing the brake with the controller in a certain position, thus requiring a conscious and sustained action on the part of the operator to put the truck in motion. The safety interlock prevents the truck from being started accidently and eliminates possibility of damage by meddlers.

DOME TYPE REFLECTOR

▲ FOR general industrial lighting applications where mounting heights of from 8 to 18 feet are encountered the Westinghouse enclosed dome type

Enclosed dome type reflector for 250 Watt mercury lamp.

reflector for 250-Watt Mercury lamp has been designed.

It consists of an 18″ diameter porcelain enameled dome type reflector with various types of hood mountings, and a dust tight hinged glass cover. The convex lens used in the cover is acid etched on the inside and smooth on the outside. The entire assembly provides a wide uniform distribution of light so necessary for low mounting types of reflectors, and the diffusing lens minimizes the glare from the lamp.

The reflector is drawn from 24 gauge iron sheet. One ground coat of porcelain enamel is applied all over, two coats white porcelain enamel inside and one green coat outside with black bead provide the reflecting surface and covering. A medium socket with high heat wax and nickel plated interior is rigidly mounted in the hood to properly locate the lamp in the reflector.

The glass cover is hinged directly to the reflector bead, supported at three points. It is released by unsnapping two latches. A heavy water proof felt provides a gasket between reflector and lens.

EQUIPMENT COMPANY ORGANIZED

▲ C. E. FESSLER, steel mill equipment sales representative of Pittsburgh, and E. R. Tyrrell, formerly chief engineer for McKay Machine Co., Youngstown, O., have organized Fessler Machine Co. to manufacture steel mill equipment in the plant of the former Turner-Fricke Co., Sharon, Pa.

With complete machine shop facilities, the company is manufacturing equipment which includes roller levelers of all sizes and designs, sheet and strip scrubbers, sheet and strip dryers, sheet and strip oiling machines, upcut shears, strip breaking machines, reel blocks, scrap balers, strip recoilers, muriatic acid dip units, rotary slitters, strip processing lines, strip shearing lines and pinch roll units.

An engineering department of eight men has been organized with K. R. Fowler, one of the designers for McKay Machine Co., in charge.

For the last 15 years Mr. Fessler has owned his own firm, Fessler & Co., Pittsburgh, sales representatives for major mill equipment companies.

Mr. Tyrrell was chief engineer for McKay Machine Co., for eight years. Prior to that he was plant engineer for Sharon Steel Hoop Co., now Sharon Steel Corp., for 10 years and before that was in the engineering department of Republic Iron & Steel Co., now Republic Steel Corp., for six years. Mr. Fessler is president of the new company while Mr. Tyrrell is general manager and secretary-treasurer.

NEW TYPE BUCKET FOR STEEL MILLS

▲ A NEW type of four-yard, hook on, two-line clam shell bucket, specially designed to meet the unusual crane conditions existing at most skull cracker pits of steel plants, has been perfected by the Blaw-Knox Company of Pittsburgh and has been in successful operation at the Pittsburgh works of the Jones and Laughlin Steel Corporation.

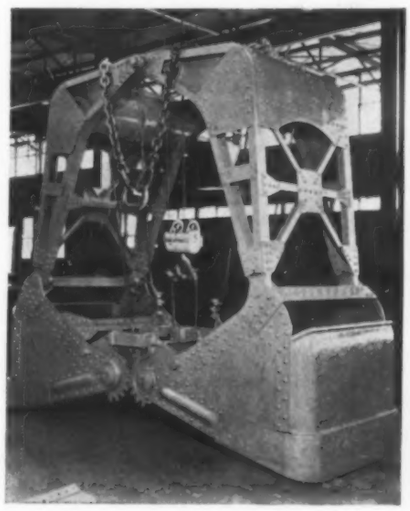
Since all single line rope-reeved type buckets necessarily require certain automatic mechanisms, the new two-line bucket designed for hook on operation eliminates many complexities and provides for greater versatility.

Owing to the fact that ladles and magnets as well as clam shell buckets must be handled at open hearth cinder pits, the usual installation is a travelling crane with two hooks arranged in a plane at right angles to the tracks carrying the cars. This arrangement of hooks makes the use of the regular type two-line clam shell buckets impossible, since the buckets would have their jaws working in the wrong position for dumping broken slag into cars. As a result of this situation, most plants use single line hook on buckets, which have obvious disadvantages since they must handle broken slag ranging from fines up to large pieces extending to the full capacity of the jaws. In handling large skulls which do not permit complete closing of the bucket, the load cannot be dropped because of possible damage from sudden closing.

The new type bucket is picked up by both the main and auxiliary crane hooks. The one hook picks up a chain sling which is attached to the bucket head and the other hook picks up the operating line. With the two cable drums spaced at three or four feet, there is no fouling of the lines, and the bucket jaws are in the proper position in relation to the cars. The bucket is provided with an open top five feet square, so that the hook operating the dumping mechanism can have a short purchase on the cable reeved directly to the bucket. This makes it possible to operate the bucket with a head room of 24 feet, which would be impossible if the hook operating the bucket were attached above the bucket as is the practice in most two-line clam shells.

The bucket is of extremely sturdy construction, weighing 22,000 pounds. The jaws and trays are made of chrome-nickel-molybdenum steel,

Four-yard, hook on, two-line clam shell bucket for use in skull cracker pits.



heat treated so that it is able to retain its properties in the presence of hot slag. This steel has a tensile strength of 100,000 pounds and has a Brinell hardness at the cutting edges of 350. The scoop side plates are made of alloy steel of a tensile strength of 80,000 to 90,000 pounds. Hinge and corner castings are made of nickel-vanadium steel with the main hinge pins of chrome-nickel heat treated steel SAE 3140. Sealed anti-friction bearings are provided for all sheaves, and high tensile bronze bearings of 250 Brinell hardness are used for the hinges.

In spite of the fact that speed ratios on the two lines normally provided on the cranes often show wide variation, it has been found that even a difference in the ratio of five to one in the speed does not interfere with successful operation.

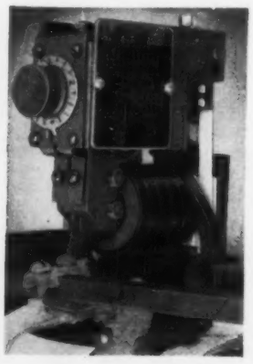
CIRCUIT BREAKER

The ability of a circuit breaker to protect production schedules without sacrifice of any safety requirement, has become more important with the development of A-C motors and particularly with the increasing use of across-the-line starting. In fact, full voltage starting has been a challenge to the designer of protective apparatus. The problem is concerned with three types of over-currents: high current inrush in the starting period; overloads of less than this inrush value but sustained for longer periods; overloads having higher value than the starting inrush.

Unless the circuit can be held intact against the starting overload, the motor obviously cannot start, and, in terms of plant production, such failure is serious. On the other hand, unless protection be provided by a device which will unfailingly distinguish tolerable starting peaks from lower but more sustained overloads and also from overloads in excess of starting inrush, the entire system is subjected to risk.

The I-T-E circuit breaker equipped with the Thermo-magnetic Overload Feature is this company's answer to the challenge. It is a device, thoroughly proved in service, which successfully "uses its head" in selecting appropriate protective action. Study of this new feature is suggested to engineers responsible for continuity and cost of production as well as those directly interested in equipment and maintenance expense. The completeness of the protection given, including the saving of production time, recommends this device as having high economic value.

Circuit breaker equipped with thermo-magnetic overload feature.



NEW BOOKLETS AND CATALOGS

▲ THE General Electric Company announces the availability of a 32 page booklet on strip chart recording instruments. Many major improve-improvements have been made in the complete line of portable and switchboard type CD strip chart recording instruments for alternating and direct current. The pages of this pamphlet illustrate some of the major improvements.

▲ A BOOK containing over 100-pages, summarizing processing equipment installed by the Mathews Conveyor Company during the past eighteen months. This book is divided into six sections: Introductory, coil handling, conveyors, sheet processing, and a section dealing with roller conveyors and wheel conveyers, all designed primarily for equipping the steel industry for continuous production.

▲ WESTINGHOUSE Flexarc motor driven welders and bare generators are described in a recent publication. Application, construction, specifications and performance curves for single operator 200, 300 and 400 amperes welders are included. Copies of the publication are available from the nearest district office or direct from Department 5-N, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

▲ A NEW catalogue on Single-Stage, Type FS Motor-blowers has just been issued by Ingersoll-Rand, 11 Broadway, New York City. This bulletin, form 2161-A, features an illustrated discussion of the theory of centrifugal air compression to pressures up to 3 pounds, and also contains an illustrated section covering the seven major fields of motorblower applications.

▲ NEW and revised booklets, announced by the Grasselli Chemicals Department, E. I. du Pont de Nemours & Company, include a new booklet on Nogas and inhibitors for pickling iron and steel.

In the new booklet on Nogas, the function and application of this non-foaming agent are explained. The booklet also carries a list of chemicals for the iron and steel industry. The booklet on inhibitors refers to the functions of an inhibitor and discusses briefly the powdered and liquid types.

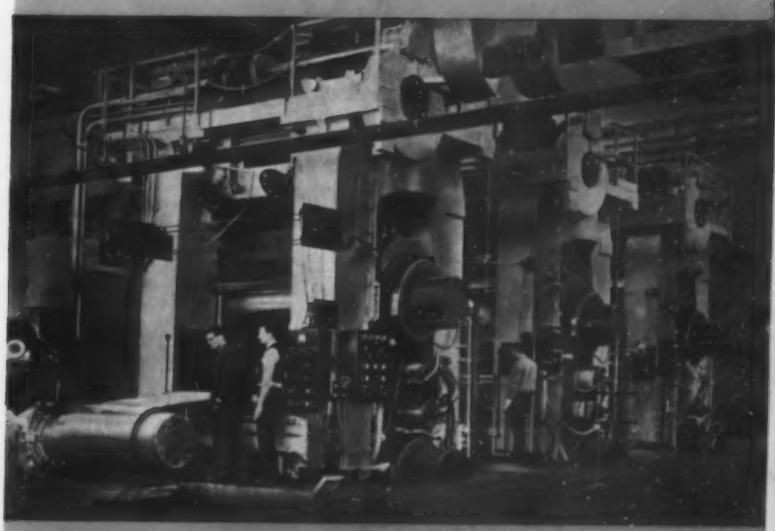
WELDING CONTEST

▲ THE James F. Lincoln Arc Welding Foundation have recently issued a brochure, outlining the purpose, rules, and conditions of a $200,000 arc welding contest. Prizes will be awarded for the best papers on the subject as applied to 44 Industry sub-classification and 11 Industry main classification, namely, automotive, aircraft, railroad, watercraft, structural, furniture, commercial welding containers, welderies, functional machinery and industry machinery. Steel making machinery is included in the latter classification.

The publication mentioned above is available to any one interested in the contest and can be secured by making request to the James F. Lincoln Arc Welding Foundation, P. O. Box 5728, Cleveland, Ohio.

BETHLEHEM'S CONTINUOUS MILL

Lackawanna N. Y.



BETHLEHEM'S

CONTINUOUS STRIP MILL...

... at Lackawanna, New York is spread out over sixty-seven acres of ground ... has a nominal capacity of 600,000 gross tons of strip, sheet and light plate ... rolls strip up to 72 inches in width and as thin as .0625 of an inch ... the pride of the world's second largest steel company.

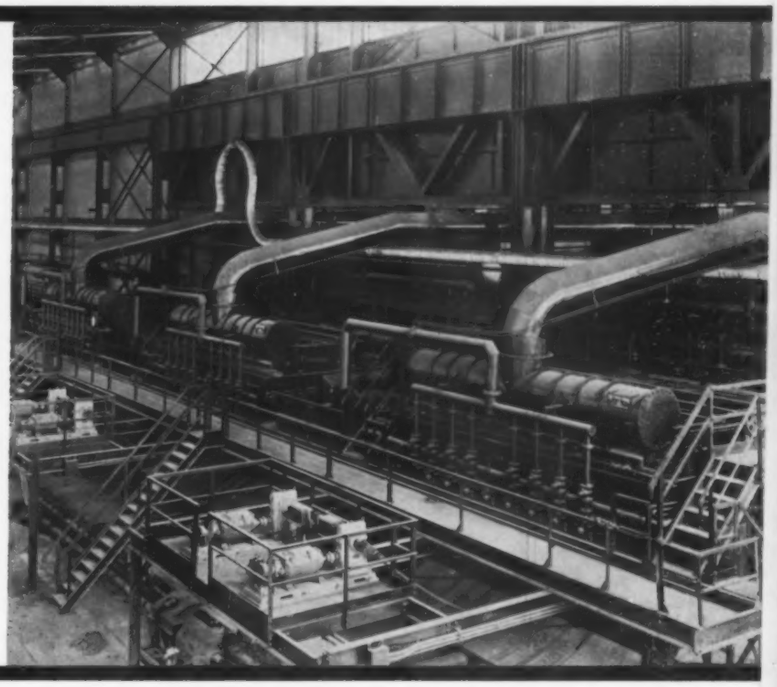
▲ THE continuous strip mill of the Bethlehem Steel Company is built on a plot of sixty-seven acres of ground adjacent to the Lackawanna plant. The mill has a nominal annual capacity of 600,000 gross tons of strip, sheet and light plate. Strip up to 60″ wide x .0625″ thick, or 72″ wide x .078″ thick may be rolled, with a minimum of 18″ wide x .05″ thick. Thus, mill design, aided by plant layout, affords a very considerable range of flexibility as to size and nature of product. This fact is emphasized by the general plan and flow sheet of the plant, which accompanies this article.

The buildings of the new plant are of standard steel frame construction, designed with particular regard for light and ventilation, and cover an area of about twenty-two acres. Wall construction is generally of brick and glass. Where intense heat is present, the buildings are of peaked roof design, with a glass monitor for light and ventilation. Where light is a prime factor, the buildings are flat roofed, high and low bay construction. Roofs of unheated structures are constructed of asbestos protected metal, while the heated structures have an insulated steel deck construction. All cold mill finishing buildings are heated by steam with unit heaters. Condensate is returned to the boilerhouse.

The interior of the hot mill buildings are painted black, while the finishing and shipping buildings are painted aluminum. Floors in the hot mill buildings are of concrete, except in places where heat would be destructive, in which case brick or cast iron plates are used. Floors of the pickling and box annealing departments are of concrete, while those in the cold mill, roll shop, processing and shipping buildings are of wood block.

Close-up aerial view of strip-sheet mill with cold mill in the foreground.

View of slab pushers in operation. All slabs move simultaneously as one is ejected ready for rolling.



Battery of recuperative furnaces showing furnace door lifting motors in foreground.

Due to the nature of the soil, which is typical of lakefront property in this vicinity, it was necessary to use a great deal of piling to properly establish the foundations which support the buildings and heavy machinery. Structural steel beams and concrete were used for this purpose.

SLAB HANDLING

Slabs from the blooming mill are chipped to remove scabs, seams or other surface defects, and are then placed in the slab storage. The storage building is 85′ wide x 925′ long. Slabs from this storage may be placed directly on the magazine pusher lift of the hot mill furnaces. This lift is driven by a 35 H.P. motor through a rack and pinion arrangement. When the switch is thrown for raising the lift, the magazine is lifted just enough for one slab to be taken from it by the magazine chain transfer. The latter is interlocked so it cannot operate unless the lift is in the proper position. The chain transfer pushes the slab onto the furnace charging table. This is a three-section table, driven by three 50 H.P. motors, which allows slabs to be placed in front of any of the three furnaces. Each furnace pusher has two arms, each driven by a 50 H.P. motor. The arms can be operated separately, or can be mechanically locked together. Pusher motor control is interlocked with furnace door hoist so the pusher cannot be operated until the doors are open.

First scale breaker in action. This has a water spray with a 1000 pound pressure.

HOT MILL FURNACES

There are three continuous heating furnaces, of recuperative, triple-fired type, with hearths 80′ long x 18′ wide. The primary heating zone is equipped with six combination gas and oil burners spaced across the width of the furnace above the steel, and six similar burners, similarly spaced, beneath the steel. The soaking zone, 16′ 9″ long, has eight smaller burners across the width of the furnace above the steel.

Each furnace has two sets of tile recuperators in which air for combustion is heated to 700-800 degrees F. The air is pulled through the recuperators by high temperature fans designed for a maximum of 1300 degrees F. Thus, air passes through the recuperators under a negative pressure, approximately balanced with the draft existing in the flue gas side of the recuperator, cutting air leakage to a minimum.

The furnaces are so designed as to heat slabs up to 16′ in length in single row, or up to 7′ 6″ in length in double row. Slab widths range 18-50 inches. Furnace roofs are of suspended arch construction, with the soaking and high temperature zones employing special non-spalling brick so as to minimize the deposition of brick particles on the heated slabs.

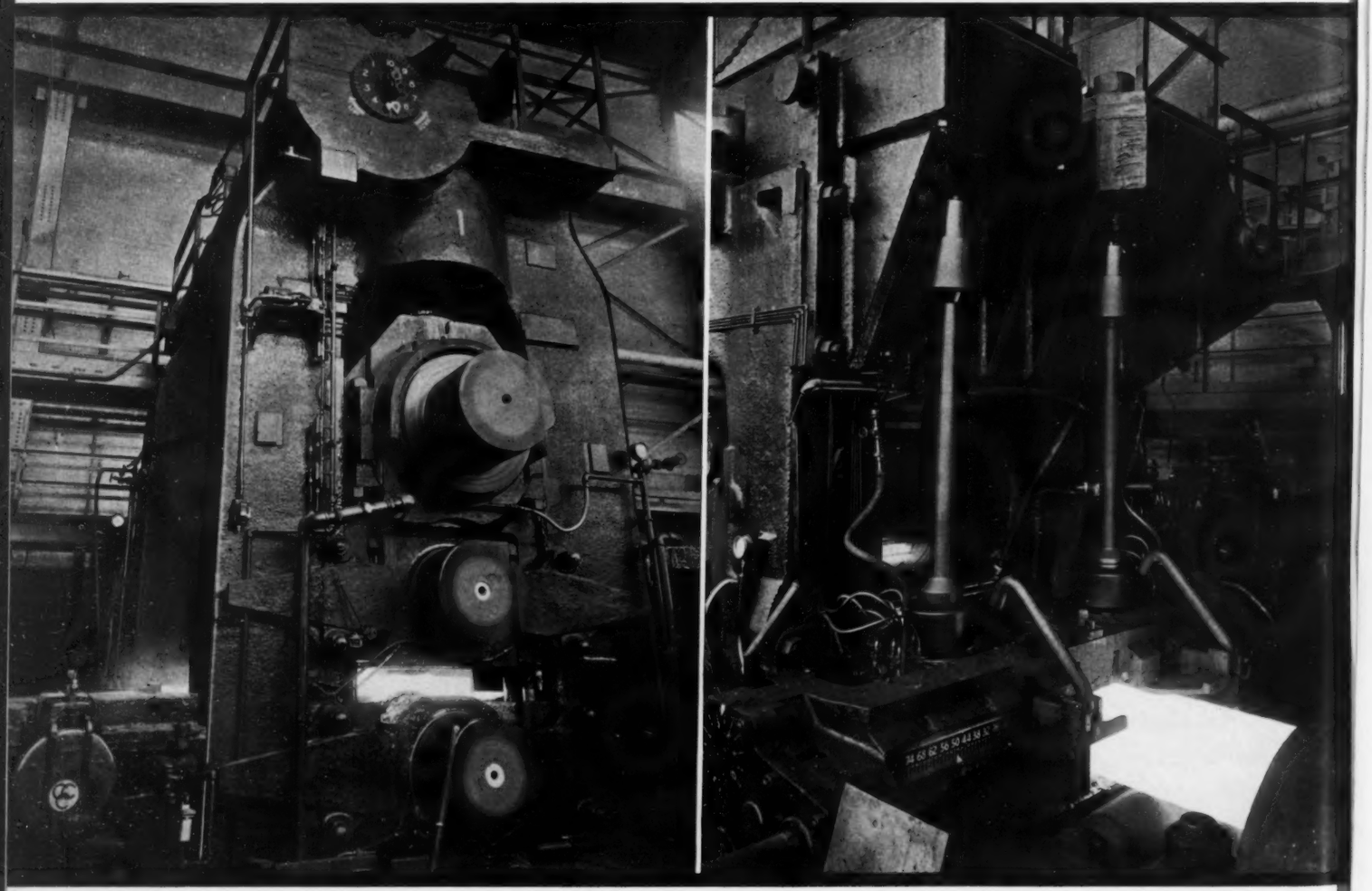
Each furnace has a nominal maximum capacity of 55 gross tons of cold steel per hour with full utilization of hearth area. Fuel consumption as low as 1,550,000 B.T.U. per ton of steel have been attained when operating at full capacity.

The furnaces are fired with mixed gas of about 285 B.T.U. per cubic foot. This fuel gas is mixed in the main steel plant, boosted to 3 lb. per square inch and piped through a 30″ main to the strip mill, where the pressure is reduced and regulated. The booster station is equipped with two 15000 c.f.m. and one 1500 c.f.m. centrifugal gas boosters, and supplies mixed gas at a rate of 1,500,000 cubic feet per hour for slab furnaces, box annealers and normalizing furnace. The burners on the furnaces handle either this gas, or, as an auxiliary fuel, oil. The latter is strained, heated and pumped by an oil-conditioning system located in the cellar of the furnace building. This system includes an instrument for automatic control of oil viscosity. The oil system has a capacity of 2500 gallons of oil per hour.

Complete metering and combustion control is provided on these furnaces, for either gaseous fuel or oil instruments for each furnace are gathered on central panels, 10′ long x 8′ high, each carrying the following:

Close-up of No. 1 mill of "roughing" train. This is where the first heavy reduction takes place.

This shows the perpendicular shafts which roll the sides of the slabs entering the second "roughing" mill.



Night-time scene of last three mills in the roughing train,

1. Furnace pressure regulator and gauge.
2. Air-fuel ratio regulator for either gas or oil for each of the three firing zones.
3. Three indicating oil flow-meters, one for each firing zone.
4. One recording oil meter for total oil to the furnace.
5. Steam and oil regulating valves and gauges controlling fuel oil and atomizing steam to each firing zone.
6. One recording gas meter, totalizing gas consumption to the furnace.
7. Recording pyrometer, showing flue gas temperatures entering and leaving the recuperator, and preheated air temperature.

A low-pressure gas alarm is also installed in the gas system, by means of which a siren sounds when the gas pressure drops to what is considered a dangerous point.

The complete layout of controls and instruments has made effiicient furnace operation a simple matter, and the effects are readily apparent in fuel economy and in quality of heating.

HOT MILL

Slabs are discharged from the furnaces at a temperature of about 2250 degrees F., and proceeding down the table, pass through a 2-high, 24″ x 76″ scale breaker. The reduction is very slight, merely enough to crack primary scale, which is then removed by 1000 lb. pressure hydraulic jets.

The scale breaker is driven by a 1000 H.P. squirrel cage motor, 375 R.P.M., 6600 volts. The next stand is a 4-high, 49″ and 36″ x 96″ mill, driven by a 3000 H.P., 6600 volt, wound rotor induction motor, 150 R.P.M. This stand is termed a broadside mill, inasmuch as slabs up to 90″ in length may be put through this stand either end-ways or broadside, the latter serving to bring the slab to a great width. Turntables are provided before and after this mill stand to bring the slab into position for broadside rolljng and then restore it to an endwise position for subsequent rolling.

The turntables are driven by 7½ H.P. compound motors, with non-reversing dynamic braking control, so arranged that on pressing a button a thrustor will be energized, which opens the valve to a cylinder and lifts the turn table. The lifting operates a hatchway limit switch which, after a definite time interval, causes the motor to turn the table 90 degrees. When this angle has been covered, a geared cam type limit switch stops the motor, de-energizes the thrustor, and lowers the turn table.

To enter mills of the roughing train, slabs of normal length need no impetus beyond that given by the table rollers. Extremely short slabs, however, may require mechanical pushing on the spreading stand only. To provide for this condition, there is a slab pusher just ahead of the broadside mill. This pusher is driven by a 150 H.P. motor, provided with reversing dynamic braking control, and so arranged that on forward stroke the motor operates with shunted armature until the pusher head contacts the slab. The motor is then speeded up to move the slab quickly into the mill. As the slab enters, the pusher motor is again slowed

down by armature shunting, and continues at slow speed until the forward stroke is finished and the motor stopped by the limit switch. The slab pusher is on runways above the roller table, and when not in use, is out of the way of ordinary sized slabs.

Leaving the broadside mill, the slab enters a squeezer which serves to true and square the slab edges, as well as exerting pressure downward in order to remove any unevenness in thickness. Slabs leaving the first mill stand usually have a lump on the front end. Elimination of this unevenness is important, particularly if the slab is undergoing cross rolling.

The slab squeezer is operated by a main motor, 275 H.P., D.C., with a 25 H.P. compound motor for adjusting, a 25 H.P. compound pump motor, three operating valves operated by thrustors, and a 12 H.P., D.C. motor for screw adjustment drive. Operation of the main drive unit of the squeezer is such that, by placing the master switch in one position, the motor will be accelerated to full speed, and after about 170 degrees travel of the squeezer, by a cam limit switch, the armature will be shunted to limit the light load speed, and after one revolution of the crank the motor will be stopped.

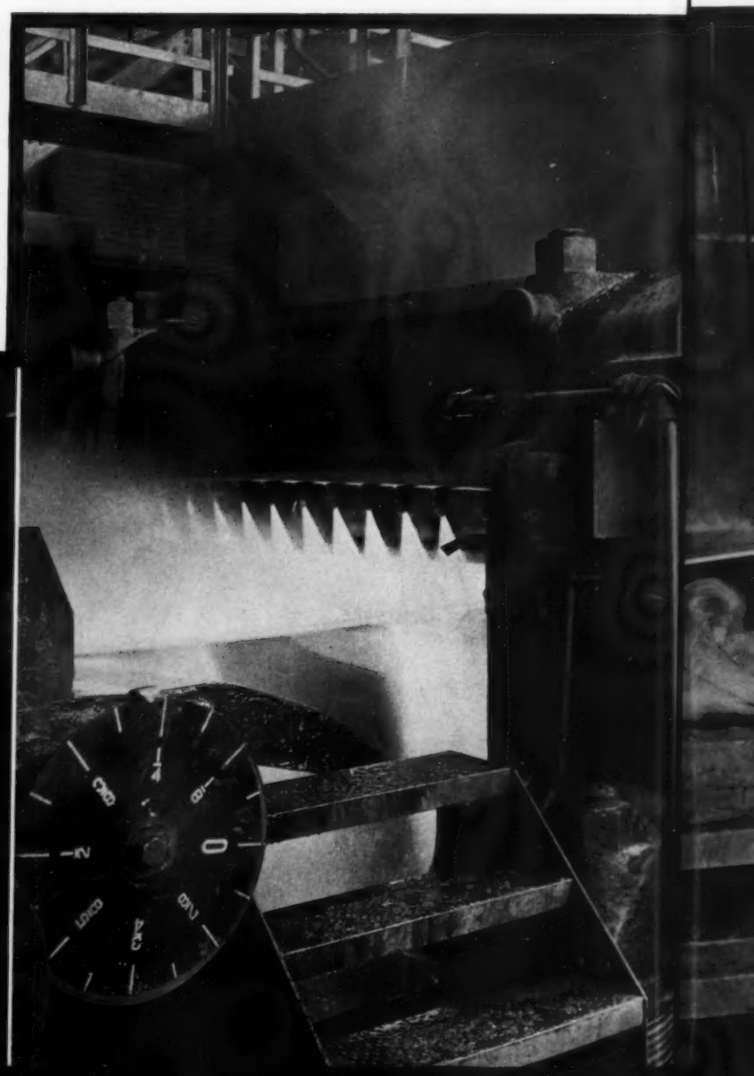
The control of the operating valve thrustors is accomplished by reversing master switches. Two of the thrustors are used to operate valves on the hydraulic hold-down. With the master switch in off position both thrustors are de-energized, and the supply and discharge valves are both closed. Putting the master into forward position energizes one thrustor to open the supply valve to the hold-down, and moving the master to reverse position energizes the other thrustor to operate the discharge valve to raise the hold-down. The third thrustor operates a check valve to control the quantity of water in the squeezer hydraulic system, as required by different sizes of slabs.

The slab then proceeds through a second set of 1000 lb. pressure hydraulic jets to remove secondary scale, and on to the three remaining roughing stands. These stands are 4-high, 49″ and 24½″ x 79″, each driven by a 3000 H.P., 6600 volt wound rotor induction motor, 500 R.P.M. The slab enters the second roughing stand at a speed of not over 50 feet per minute, and leaves the last rougher at a speed of about 410 feet per minute. All roughing stands are spaced far enough apart so the slab is in only one stand at a time. Steam sprays are used on No. 4 roughing stand for cleaning the steel.

On all stands of the roughing train are placed adjustable side guards, which assure proper entry of the slab into each stand. The three latter stands are also equipped with vertical rolls on the entry side, for edge-rolling of the slab. The edger rolls are integral with the mill stand, and are driven by a 150 H.P. adjustable speed shunt motor, mounted on top of the mill stand. They are provided with reversing plugging control, and their speed is indicated by tachometers. Adjustment of each of the edging rolls is made by a 12 H.P., D.C. series motor with reversing plugging control, and over-travel is prevented by the use of hatchway limit switches.

Leaving the roughing train, the slab has been reduced to approximately one-fifth of its original thickness, and is now between ⅝″ and 1¼″ in thickness. It next passes over a roller table about 95′ long, leading to the

High pressure water spray removes oxide and surface [illegible]*ration scale as slab leaves No. 2″ scale breaker.* [illegible] *of the*



Cooling-table view of elongated slab as it leaves last roughing mill.

finishing train. This table serves as a cooling table, on which the steel temperature is allowed to drop to the proper point for finishing. Special water cooling is provided in the table rollers. An optical pyrometer measures the temperature at this point, and 1900-1950 degrees F. seems desirable.

The slab next enters a second scale breaker, followed by 1000 lb. pressure water sprays and then a flying crop shear which removes uneven ends which might mar the finishing rolls.

From this point, the strip passes through six 4-high finishing stands, 49″ and 24½″ x 79″, driven by three 3500 H.P., two 4500 H.P., and one 2500 H.P., adjustable speed D.C. motors, 600 volts. Horsepower indicators show the load on each finishing drive on large dials which are located in view of the operators. With this aid, the load can be properly distributed over the six stands. From various pulpits along the mill, the drives and auxiliaries may be controlled as necessary to mill operation. Steam jets for removing scale and dirt are on each finishing stand.

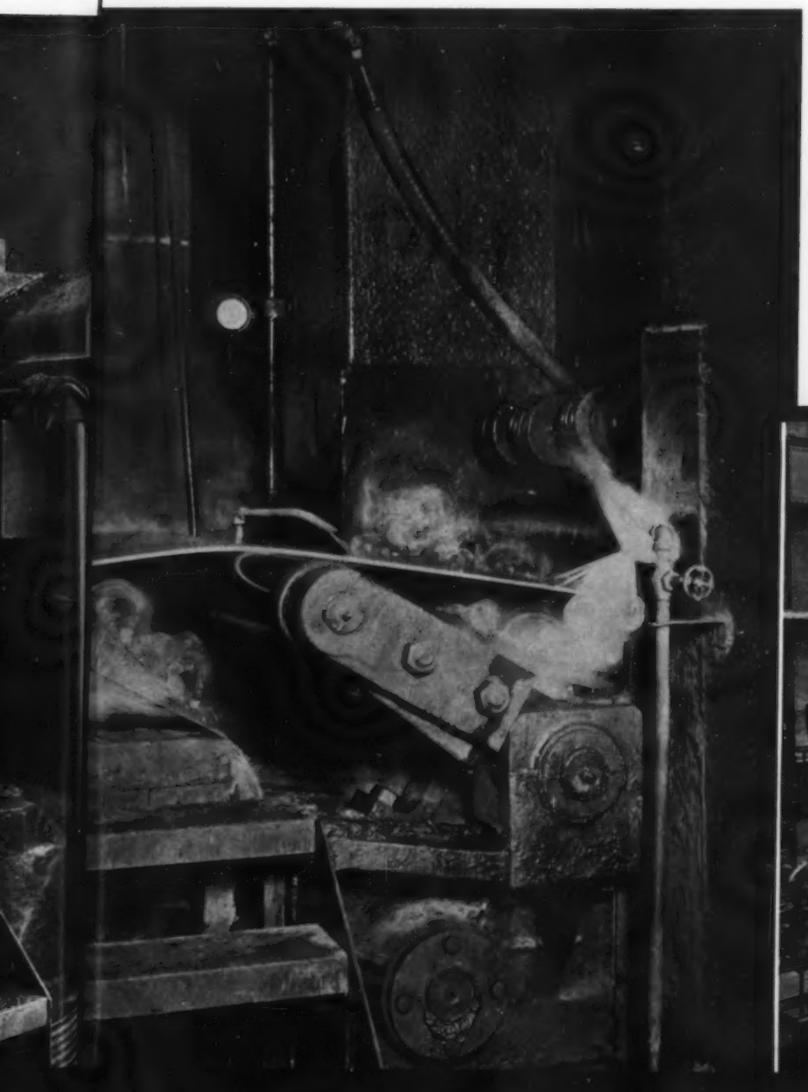
Screwdowns on each stand are driven by two 70 H.P. compound motors which can be coupled together through a 20″ diameter magnetic clutch having 1500 lb. ft. torque. For control of these motors, there is provided a two motor impulse type control, so arranged that the master switch raises or lowers the screwdowns with the motors coupled together. On each stand there are also mounted push-buttons for jogging either motor separately, or both motors together, as may be necessary for roll setting. Screwdowns are gauged by large dials, indicating in thousandths of an inch.

Strip is delivered from the hot mill at speeds ranging from 676 to 1352 feet per minute, depending on the gauge. An optical pyrometer measures the temperature of the strip as it leaves the finishing train.

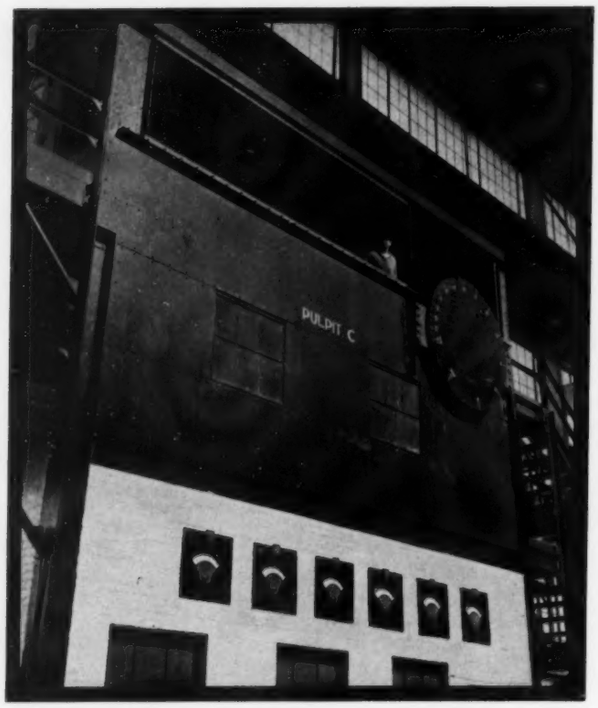
Immediately following the finishing train is a flying shear, in which the moving strip may be cut to any pre-determined length from 11′ to 22′. The shear is driven by two 150 H.P. shunt wound mill type motors. The shear is synchronized with the speed of the strip. Speed of the motors is controlled by a motor-generator set consisting of a 750 H.P., 440 volt synchronous motor driving a 500 K.W. compensated shunt wound generator, a 25 K.W. exciter and a 5 KVA, 3 phase frequency changer. The latter furnishes 60 cycle supply for the synchro-tie indicating system. Shear control is so arranged by the use of a special gear unit, an electronic timer, variable voltage control of the M.G. sets, a load relay, and cam limit switches that the shear will automatically cut the front and rear crop from the strip, or can be set to cut it into desired lengths as mentioned above.

Two coilers are provided in the run-out table of the hot mill. Coiler doors open on the roller table, and the strip drops down about 8′, where it is wound around a mandrel. An air operated extractor pushes the coil off the mandrel, from where it is deposited on a chain conveyor operating through an underground tunnel about 260′ long to a storage space in the cold mill building. Each coiler requires four 5/15 H.P. coiler roll drives, one 5/15 H.P. guide roll drive, a 20 H.P. pinch roll drive, all of which are water-cooled, 6 pole, 147/440 volt A.C. motors. Besides these variable fre-

vation of this looping roll takes up slack and maintains tension of the rapidly moving strip that leaves the "finishing" train.



The finishing train of six rolling mills and a scale breaker. The transition from slab to strip takes place here.



The finishing train is controlled from Pulpit "C" shown above. The horsepower indicators are attached to wall at right.

quency motors, each coiler also requires a 20 H.P. A.C. feed drive motor and a 7½ H.P., D.C. spring adjustment drive. The control of these coiler motors is accomplished with a variable frequency M. G. set.

About 900 motors, ranging in size from .66 to 10 H.P. are used to drive the 1700 rollers in the plate and sheet finishing department tables. The motors on certain tables are adjustable speed A.C., and are synchronized to operate the roller tables to suit the speed of the product from the mill.

HOT MILL MOTOR ROOM

The hot mill motor room is 65′ x 475′, and is located alongside the hot mill. The twelve hot mill motors, described elsewhere in this article, are located here, and are segregated into two groups, the roughing drives and the finishing drives, powered respectively by A.C. and D.C. The roughing motors are controlled by liquid slip regulators of the Lewis type, with torque motors for starting, to reduce power peaks. Dynamic braking is provided by D.C. current through mechanically and electrically interlocked oil circuit breakers. The finishing motors are all 600 volt D.C. adjustable speed shunt wound, 250 volt separately excited, motors, with compensated winding. They total 22500 H.P. connected D.C. load.

There are also six variable frequency M.G. sets on the roller tables and coilers. Each set consists of two 125/250 H.P. motors direct connected to one 166/550 KVA, 50 degree C., 20/60 cycle, 144/440 volt, 400/1200 R.P.M. alternators. These units add 3000 H.P. load on to the 600 volt D.C. bus system.

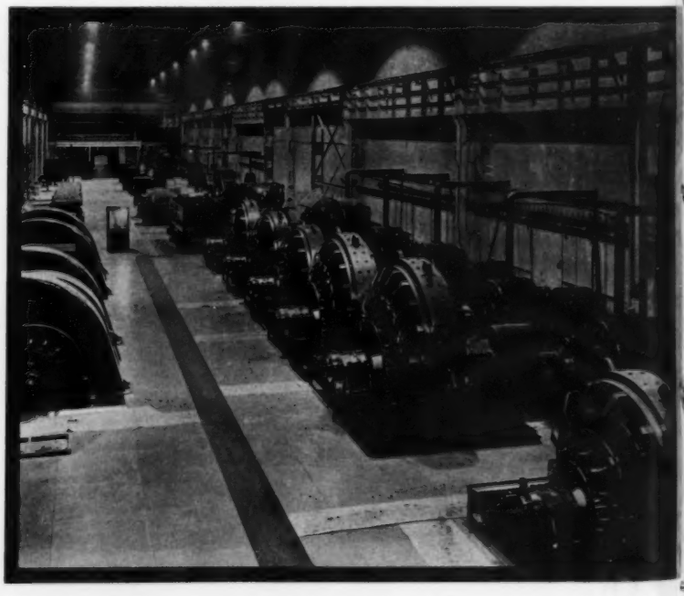
To supply this D.C. load and to provide adequate means of starting, dynamic braking and reversing, there are two 6000 K.W. motor-generator sets, each consisting of two 3000 K.W. 600 volt D.C. generators, compensated shunt wound, direct connected to one 7200 KVA, 90% P.F., 8500 H.P., 40 degree C., 375 R.P.M., 6600 volt, 3 phase, 25 cycle synchronous motor with 250 volt D.C. separate excitation.

For 250 volt D.C. auxiliary power there are two 1500 K.W., 80% P.F., 500 R.P.M., 6600 volt, 2250 H.P. synchronous M.G. sets. The motors are designed for full voltage starting, requiring 500% K.V.A. inrush in terms of normal rating. The two generators are self-excited, flat compound wound. They operate in parallel and are equipped with an equalizer connection. They feed into a common bus through 8000 amp. air circuit breakers equipped with overload, undervoltage, and reverse current protection. Each set is equipped with an overspeed device which trips the D.C. breaker if the machine overspeeds. The power is distributed through the mill over six feeders, each with a capacity of 3500 amps. and fed through a 4000 amp. air circuit breaker with overload protection.

The M.G. sets and control panels for the hot flying shear are also located in the motor room, along with the high tension circuit breakers, control panels for the large motors and for various auxiliary motors.

Auxiliary A.C. power is supplied through a bank of three 1000 KVA single phase transformers, 6600/440 volt, connected delta-delta. This power is distributed through the mill over four feeders, each having a carrying capacity of 1700 amp., fed through a 1600 amp. 3 pole breaker. Taps for 220 volt are available for use on space heaters on machines and slip regulators. For

Motor room housing the drives for the hot mill stands. A total of 12 motors is located here.



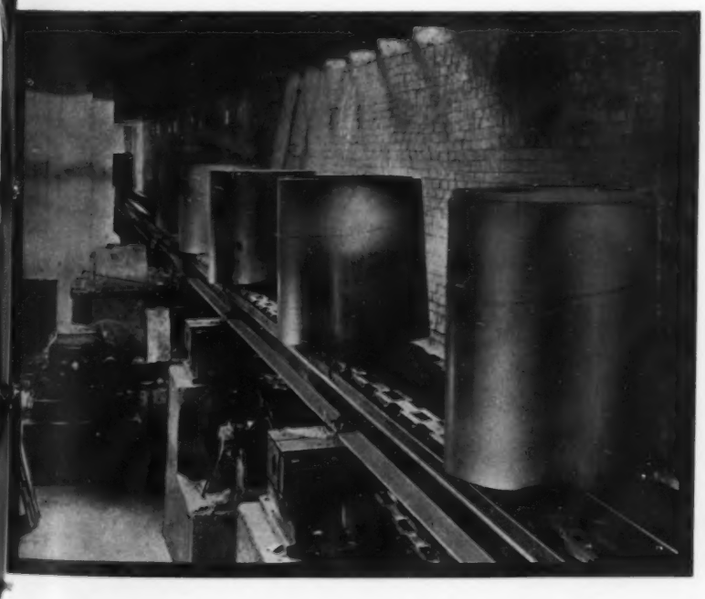
lighting, a bank of three single phase, 500 KVA air-cooled transformers, 25 cycle, 6600/440 volt, is provided, connected delta-delta. This bank operates on the primary side only with the same oil switch as the 3000 KVA power bank.

The ventilating and cooling system for the rotating electrical machinery in the motor room is of the re-circulating type, in which the air, after passing through the machines, is cooled in 10 surface type air coolers, and again returned to the motor room by blowers, and again passes through the machines. A system of this type discharges all of the cool air into the motor room, and thus affords the advantage of a cool motor room at lower costs, while keeping the machines cool and clean also.

PLATE FINISHING

If plate is being rolled, the material is side-tracked as it leaves the finishing train, and enters the plate finishing department over a roller table about 300′ long, equipped with individually motor driven rollers. Then a chain transfer bed 250′ long moves the plate sideways to a second roller table about 700′ long. The plate then passes through a roller leveller and on to an end shear, where the mill lengths are reduced to stock lengths of 100′ maximum. Additional transfers and roller tables carry the plates on to storage, or through another finishing line in which are located a rotary side trimming shear, a roller leveller, and an end shear. In addition, a light plate trimming unit, consisting of a rotary side trimmer and slitter, a leveller and an up-cut shear, is provided to handle special orders for plates $\frac{5}{16}$″ thick and under. The long travel on roller tables is necessary to give the plate time to cool down for subsequent handling.

Underground tunnel conveyor for transferring the coils from the hot mill to the cold mill building.



One of the coilers in action at the end of the run-out table. It winds strip in ribbon like fashion at a very high rate of speed.

Four resquaring shears are provided to take care of sheets and plates. A special device in the plate building, used in connection with the light plate trimming line, is a charging car, designed for charging one plate at a time. Mounted on this car is a rocking arm, on the end of which are mounted twelve small magnets of such capacity as to lift only one plate at a time. This car is used on material too heavy to be man-handled and too light to warrant the use of overhead cranes. It will handle plates up to $\frac{5}{16}$″ in thickness and up to 2250 lb. in weight. Operation of the car is entirely automatic for a complete cycle.

HOT ROLLED SHEET FINISHING

Sheets to be finished direct from the hot mill are cut into the desired lengths on the flying shear previously mentioned. and proceed down the run-out table to a piler. From here the sheets may pass through either of two trimming units designed for thicknesses up to $\frac{3}{16}$″. Each of these units is made up of a side trimmer, a roller leveller, and an up-cut shear, and are followed by gravity conveyors from which sheets are piled either for storage or for further processing. Material 12 gauge and lighter is coiled, and later cut into lengths on either of the two trimming units or on a cutting up line, and then processed in the same way as the cut lengths from the mill. A 150′ normalizer is installed for sheets requiring this treatment. This furnace has

a 75′ heating zone, fired with mixed gas, and a 75′ cooling zone. Roller hearth construction is used, with rollers of heat resisting alloy in the heating zone. Sheet pickling may follow in a four armed pickler, of the vertical plunger mast type. The pickling vats are lined with an impervious brick laid up with acid resisting cement.

The pickler is served by a turntable about 3′ high, upon which are placed crates of sheets ready for pickling and after pickling. Thorough washing and scrubbing them follow. After this comes roller leveling and then perhaps skin pass cold rolling, oiling, or other process preparatory to storage or shipment.

COIL PICKLING

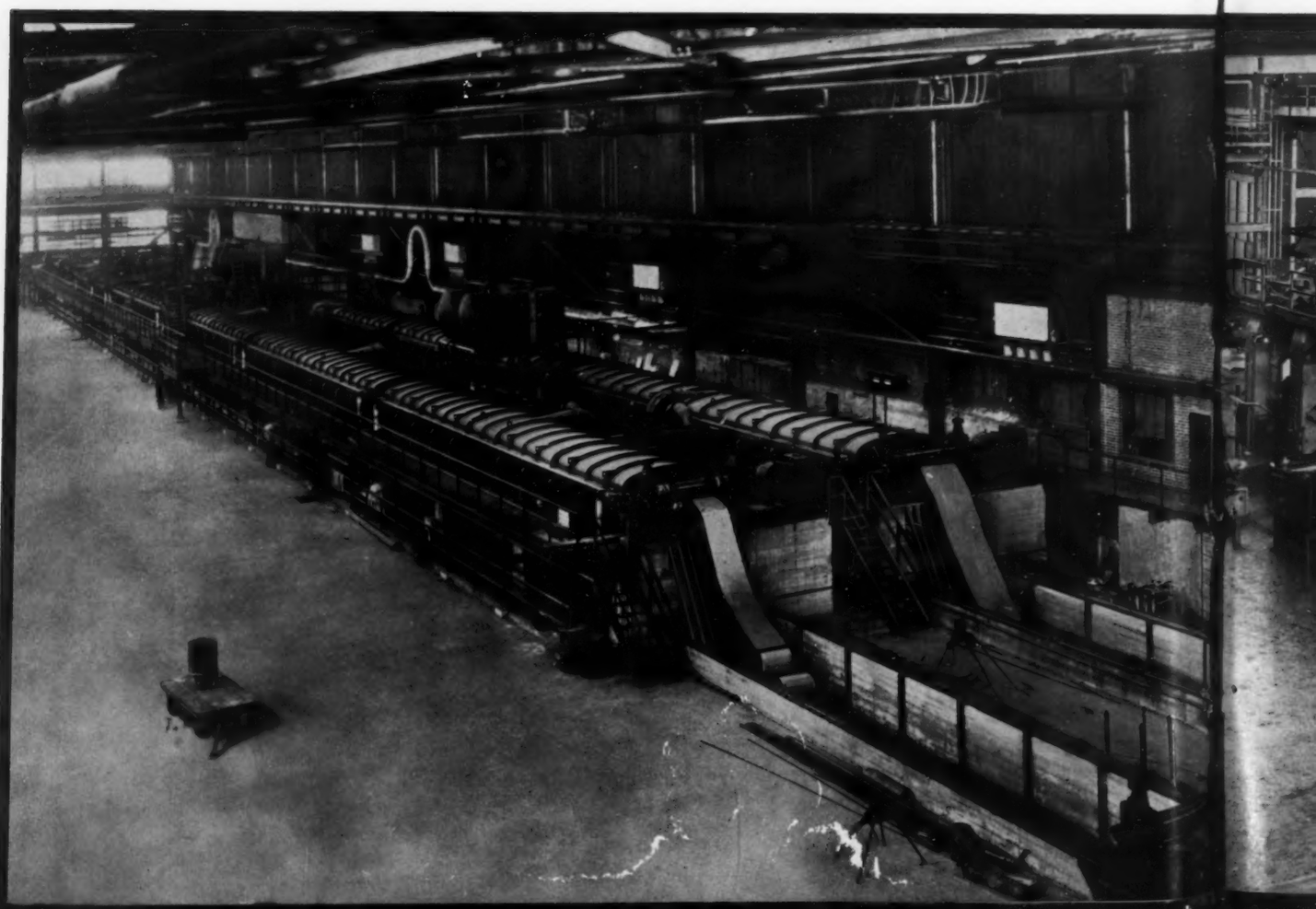
Strip intended for full finishing is taken from the hot mill in coil form. From coil storage, an overhead magnet moves the coils to the two continuous pickling lines. Each line is over 300′ long. The strip first passes through an uncoiler and a processing machine, and then to a shear which evens up the ends. The adjacent ends of successive coils are lapped and the ends stitched together. The strip passes through a looping pit and on through pinch rolls, continuing through the pickling and wash tanks which are elevated about 10′ above the preceding levels so the pickled metal on discharging can proceed by gravity to its next storage point at the tandem mills, about 150′ away.

The first four tanks in each pickling line are 60′ long x 84″ wide, and each contain about 11000 gallons of an 8–12% solution of sulphuric acid at an automatically controlled temperature of about 180 degrees F. These tanks are constructed of a steel shell, 61′ 5″ long x 8′ 6″ wide x 4′ 8″ deep. The steel is protected by a lining of rubber vulcanized over its interior surface. The rubber lining totals about ¼″ in thickness, and is made up of a layer of soft rubber, a layer of hard rubber, and another layer of soft rubber. To protect the rubber from abrasion there is another lining, 8″ in thickness, of hardburned brick, laid in two courses, with an acid resisting cement having a sulphur base. Tanks are emptied by combination syphons and overflows constructed of lead. Arched steel rubber lined covers are used on the tanks to prevent fumes from escaping into the building. Fume ducts are connected into each tank, which, together with rubber lined exhaust fans and a scrubber, or neutralizer, carry the fumes through a tile sewer to a high asbestos protected metal stack.

The acid tanks are followed by two 25′ wash tanks of similar construction, the first containing cold water, the second, hot water. Following this is a hot air dryer and a pinch roll which pulls the strip through the entire pickling line. The stitching is next cut out and the strip then passes through an oiling machine and on to a recoiler. The coils are weighed before and after the pickling process in order to ascertain pickling loss.

Strip speed through the pickling lines may range 55–165′ per minute.

Two continuous pickling lines showing strip entering the tanks. Each of these lines is over 300′ long.



COLD MILLS

After pickling, the next step is cold rolling, which is accomplished in one of two tandem trains of three stands of 4-high mills. One set of mills is designed for coils up to 48″ maximum width, while the other will roll up to a width of 72″. A reduction in gauge of about 60% is customary for full cold rolling. Synchronization of the mills is effected by an elaborate system of control. To provide starting, dynamic braking and reversing for the tandem mills by Ward-Leonard control, one 6000 K.W., 8500 H.P. motor generator set (duplicating the two in the hot mill) is used. For supplying constant potential excitation to motors and motor-generator sets, there is a 200 K.W. generator driven by a 300 H.P. synchronous motor. Both mills are equipped with reels for recoiling the strip. Electro-limit gauges are provided for accurate and continuous inspection of gauge, consisting essentially of an electric head for gauging the metal, a power unit to provide 60 cycle and proper voltage, and a micro-ammeter to indicate thickness to the operators.

The two tandem mill trains have a capacity of 38000 tons a month, and are capable of producing cold rolled strip ranging 18½″ to 72″ in width, and from .0125″ in thickness for narrow widths up to .109″ thickness. Delivery from the mills may reach a top speed of as much as 660 feet per minute.

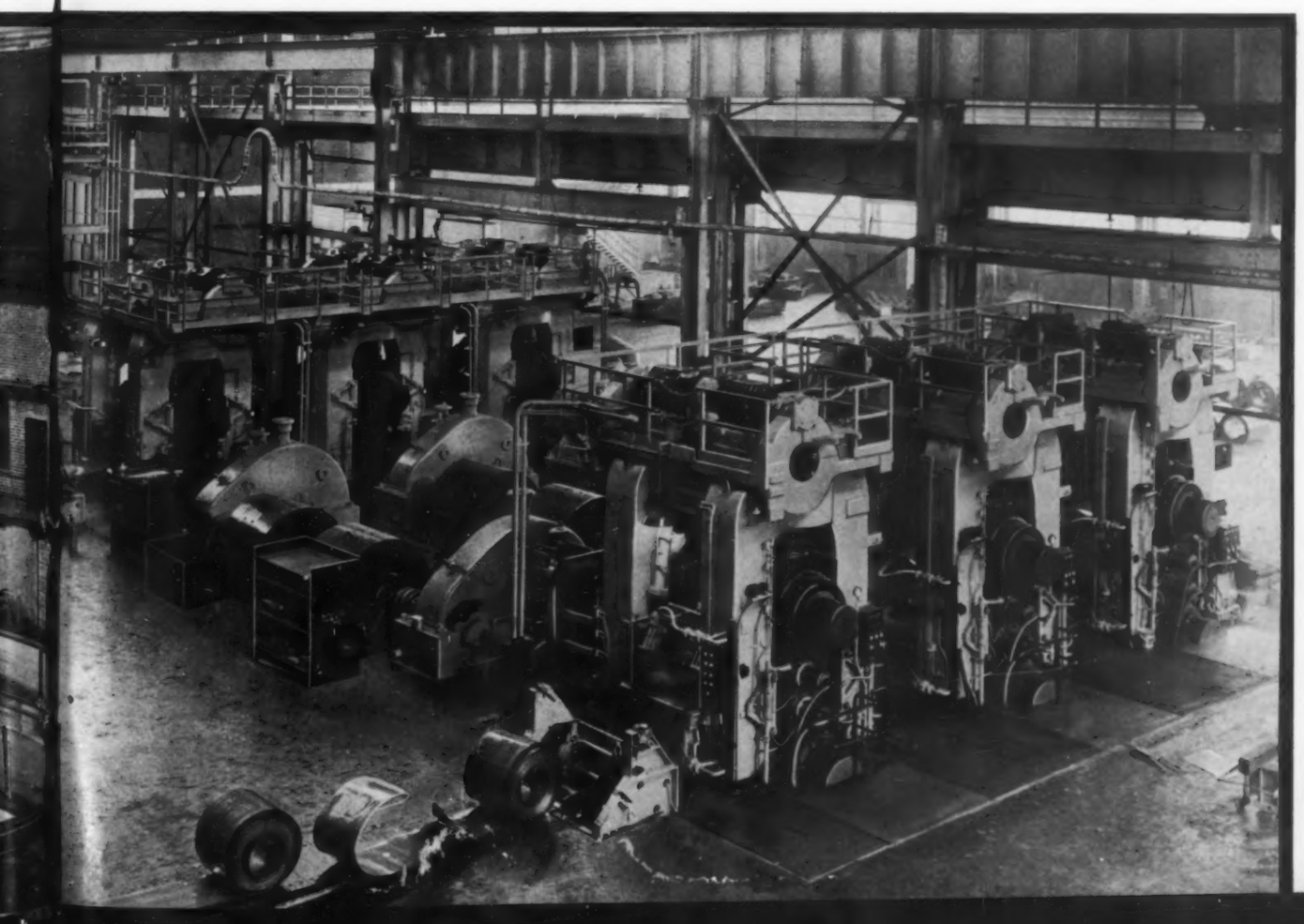
Details of these mills and their drives are given in the accompanying table.

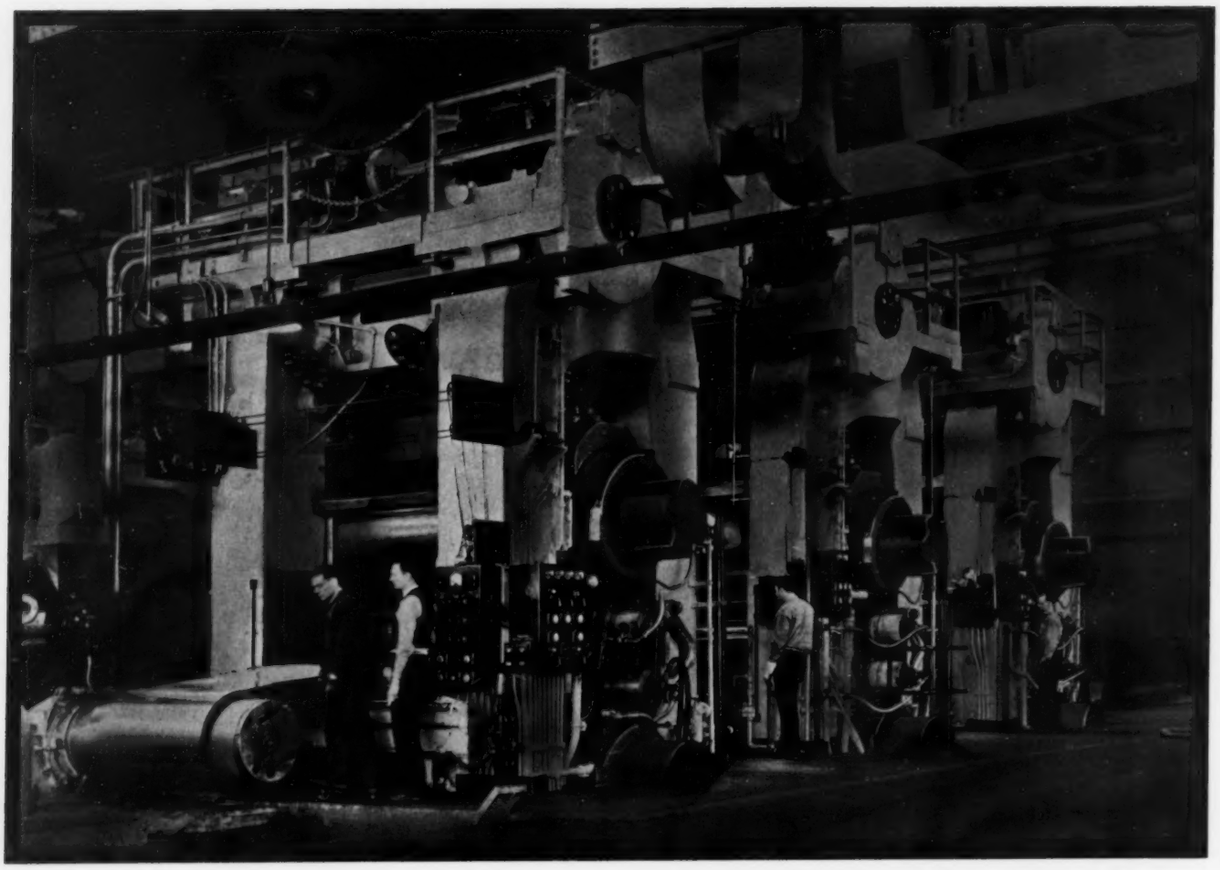
Coils from the tandem mills pass through a cutting line, of which there are three, each consisting of a feed reel, a trimmer and a combination leveller and flying shear, all arranged in tandem. The product is then in sheet form.

Box annealing, the next process, can be done on material either in sheet or coil form. The annealing equipment consists of thirty-one furnaces that will accommodate sheets up to 75″ in width x 220″ in length, or coils up to 59″ in width; and five furnaces capable of taking sheets up to 84″ x 186″ or coils up to 72″ in width. Eight additional furnaces, size 90″ x 250″, are now being installed. The furnaces are all of the radiant tube type, each furnace consisting of one outer cover with four bases and inner covers. These furnaces are fired with mixed gas and equipped with automatic temperature control. When coils are to be annealed, they are first uncoiled, then recoiled very loosely to allow better heat penetration. Five gas conditioning units, each with a capacity of 15000 cubic feet per hour, are installed for the preparation of a gas suitable for deoxidizing purposes in the annealing process.

The annealed sheet or coil may then be given a cold skin pass or tempering pass, amounting to a cold reduction of one to three percent. By this means, hardness and ductility of the steel may be modified, and the surface smoothed and polished. For this purpose

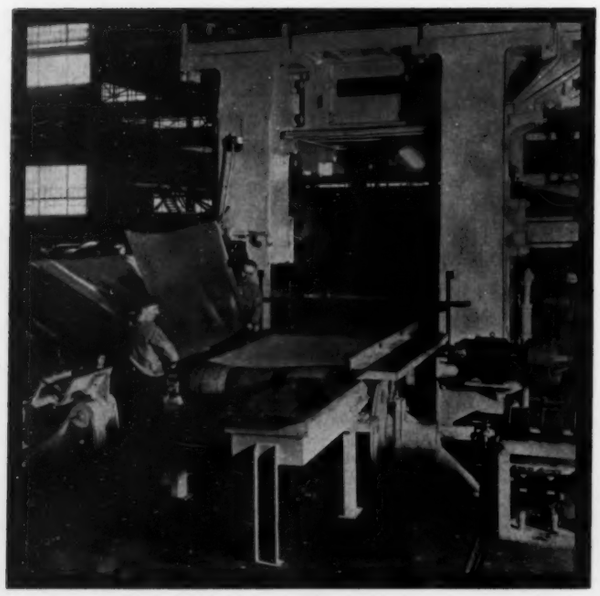
Two sets of three stand cold reduction mills. These mills have a capacity of 38,000 tons a month.



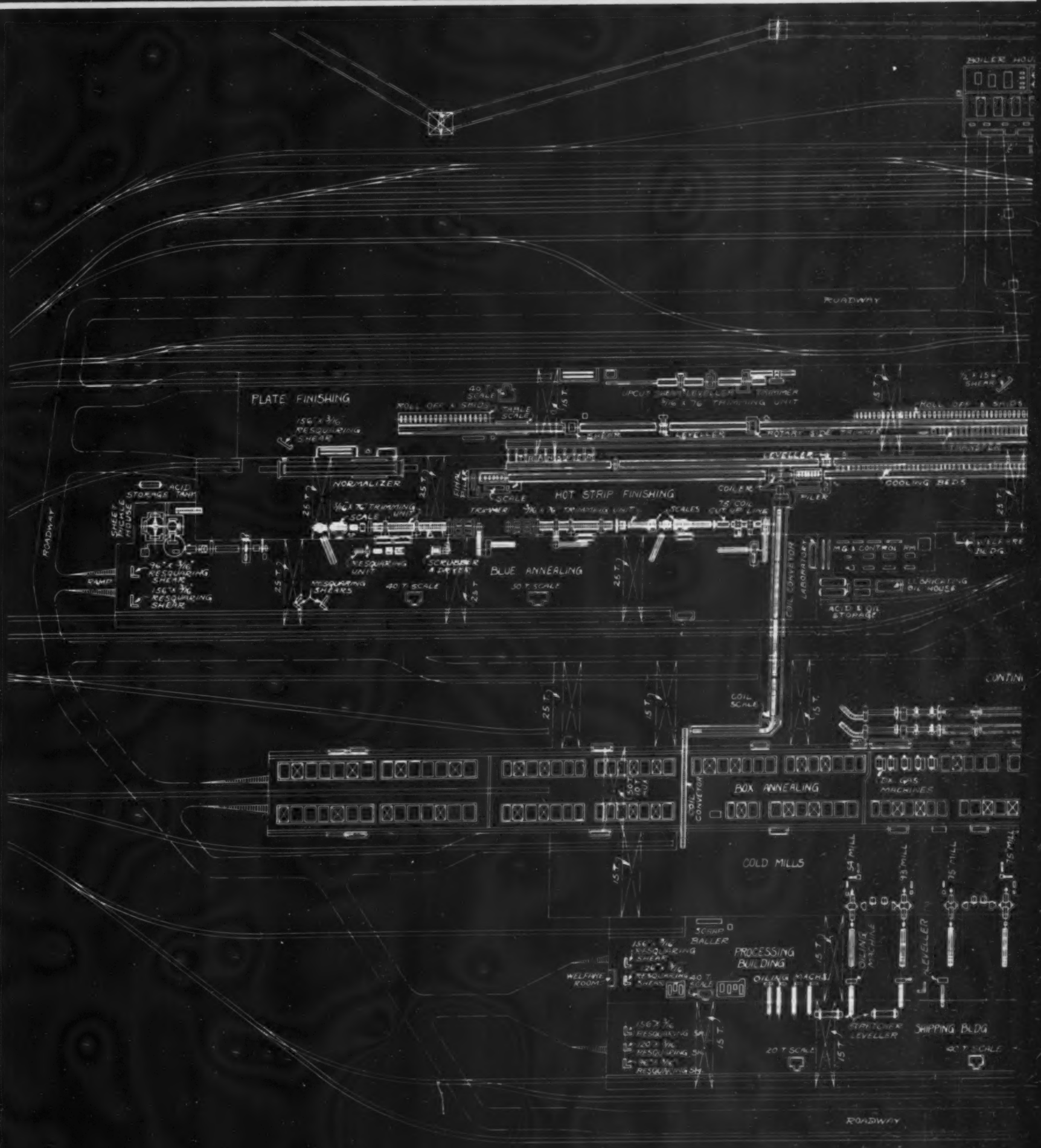


Closeup view of cold mill showing delivery end. This has a top delivery speed of 660 feet a minute

These sheets are receiving their final skin pass rolling.



The box-annealing building is flanked on either side by a long row of furnaces.



PLAN VIEW - HOT AND C(

BETHLEHEM STEEL COMPAI

[AND COLD STRIP MILLS

COMPANY, LACKAWANNA, N.Y.

CHIPPING

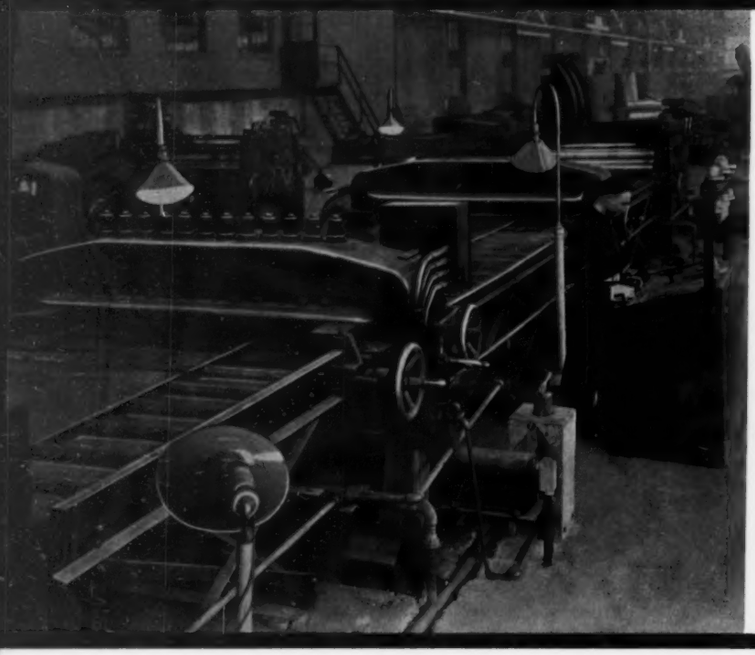
TABULATION OF MILL AND DRIVE DATA

Mill	Characteristics	Work Roll dia.	Back-up roll dia.	Roll Lgth.	Motor H.P.	Volts	Motor RPM	Motor Type	Remarks
HOT MILLS									
Scale breaker.....	2-high, 1-stand	24″		76″	1000	6600	375	Squirrel cage	Geared
Broadside mill ...	4-high, 1-stand	36″	49″	96″	3000	6600	150	Wound rotor ind.	"
Rougher.....	4-high, 1-stand	24½″	49″	79″	3000	6600	500	Wound rotor ind.	"
Rougher.....	4-high, 1-stand	24½″	49″	79″	3000	6600	500	Wound rotor ind.	"
Rougher.....	4-high, 1-stand	24½″	49″	79″	3000	6600	500	Wound rotor ind.	"
Scale breaker.....	2-high, 1-stand				500	600	150/600	DC	"
Finishing stand...	4-high, 1-stand	24½″	49″	79″	3500	600	175/350	DC	"
Finishing stand...	4-high, 1-stand	24½″	49″	79″	3500	600	175/350	DC	"
Finishing stand...	4-high, 1-stand	24½″	49″	79″	3500	600	175/350	DC	"
Finishing stand...	4-high, 1-stand	24½″	49″	79″	4500	600	125/250	DC	"
Finishing stand...	4-high, 1-stand	24½″	49″	79″	4500	600	125/250	DC	"
Finishing stand...	4-high, 1-stand	24½″	49″	79″	2500	600	175/350	DC	"
COLD MILL									
Tandem mill.....	4-high, 3-stand	20″	49″	75″	(3) 1250	600	300/600	DC	Geared with reel
Tandem mill.....	4-high, 3-stand	20″	49″	54″	(3) 1250	600	300/600	DC	Geared with reel
Skin pass mill....	4-high, 1-stand	20″	49″	75″	1250	600	300/600	DC	Geared with reel
Skin pass mill....	4-high, 1-stand	20″	49″	75″	1250	600	300/600	DC	Geared without reel
Skin pass mill....	4-high, 1-stand	24″	49″	93″	1250	600	300/600	DC	Geared without reel
Skin pass mill....	2-high, 1-stand	28″		55″	250	250	500/1000	DC	Geared with reel

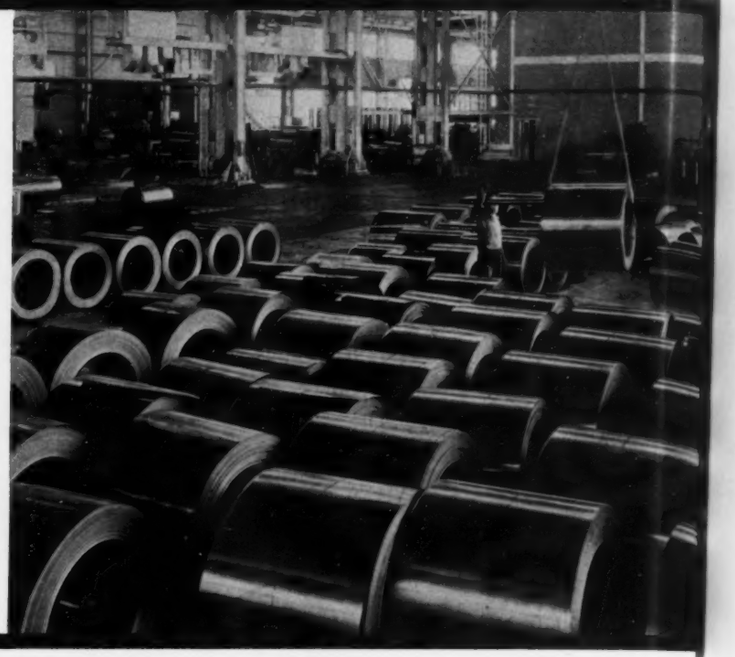
there are installed two 4-high mills, 49″ and 20″ x 75″; one 4-high mill, 49″ and 24″ x 93″; and one 2-high mill, 28″ x 55″. All these mills will skin roll sheets singly, and one of the 75″, 4-high mills and the 55″, 2-high mill, are equipped with feed and tension reels for handling coils.

Power for the skin pass mills comes from one 2500 K.W. 600 volt D.C., 3750 H.P., 90% P.F., 40 degree C., 25 cycle, 6600 volt, 750 R.P.M. synchronous motor generator set, and one 1300 K.W. 250-600 volt—by switching—D.C., 2000 H.P., 90% P.F., 40 degree C., 25 cycle, 6600 volt, 750 R.P.M., synchronous set. These units, together with the set for the tandem mills, are located in a building close to the mill stands. Power is transmitted from generators to the several motors through a system of bus work in underground tunnels. Control apparatus for the cold mill motors is located in control rooms under the motors and pinions.

Final operations preparatory to shipping may include roller leveling, resquaring, oiling, etc. Strip in coil form can be delivered in widths ranging from 1″ to 72″, in varying thicknesses from .0125″ to .125″. To supply widths of 18″ and under, wider strip is put through slitting machines.



This machine stitches together the ends of coils prior to their passing through the pickling tanks.



Coiled strip fully processed for shipments to those buying it in this form.

Full finished sheets is the major demand of the customers.

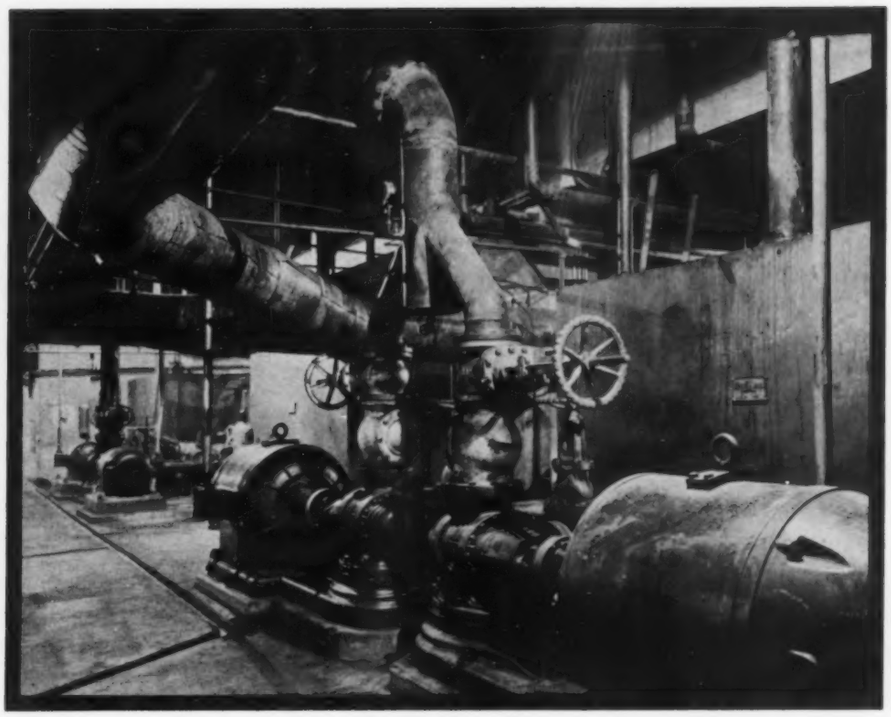
POWER

A summary of rotating electrical machinery in the entire strip plant follows:

	Number	H.P.
Motors—Hot Mill	1407	81551
Generators—Hot Mill	24	23850
Total Hot Mill	1431	105401
Motors—Cold Mill	514	35050
Generators—Cold Mill	18	13675
Total Cold Mill	532	48725
Total Installation	1963	154126

A summary of connected load of the plant is given in the accompanying table.

Electric power for the plant is delivered from Niagara Falls over a 60000 volt system to an outdoor substation near the plant, where there are three single phase 5000 KVA water cooled 60000/6600 volt transformers. There is also provided a tie into the main steel plant power system. From the sub-station, power is distributed to the hot mill motor room and the cold mill substation by an overhead transmission system.

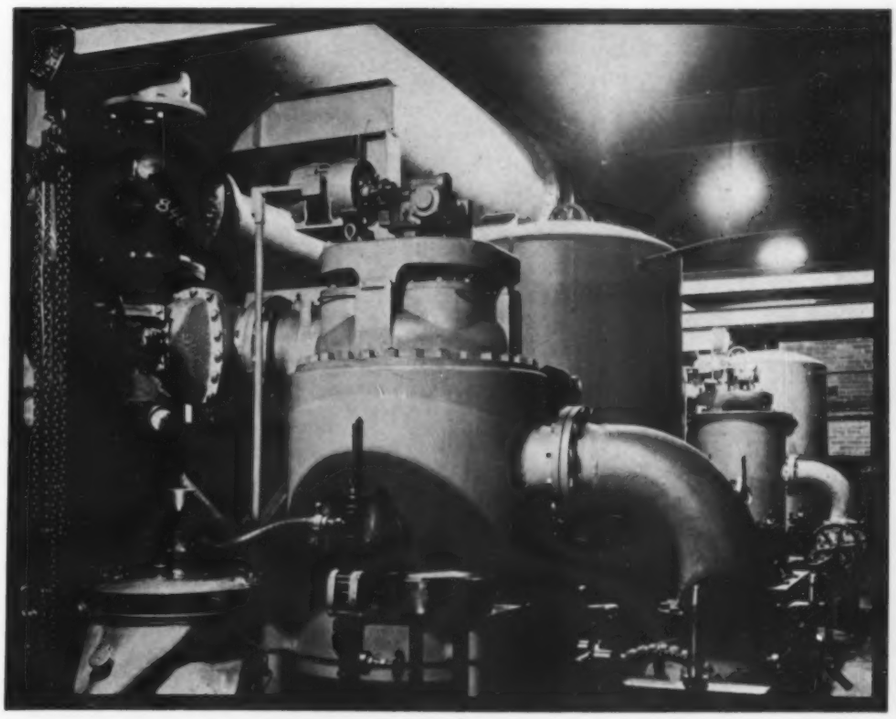


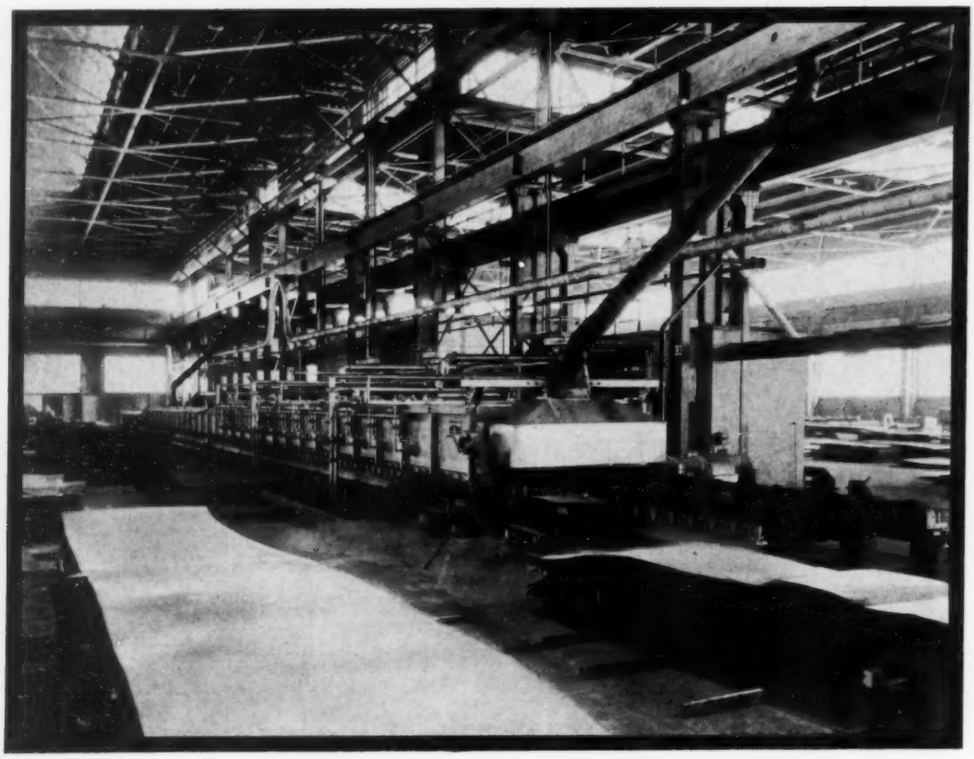
Section of lubricating oil storage built underground. Four 10,000 gallon storage tanks are located here.

LUBRICATION

Lubrication of the hot mill proper is accomplished by four separate oiling systems, each with its own 10000 gallon storage tank, automatic pumps, filters, centrifuge and cooler for conditioning the oil. System No. 1 lubricates the gear reducers; system No. 2, the pinions and edgers; system No. 3, the back-up rolls; and system No. 4, the motors. Lubricating equipment is installed in a cellar adjacent to the mill train, in a rather unusual layout. From a central pump room, distribution is by pressure from circulating

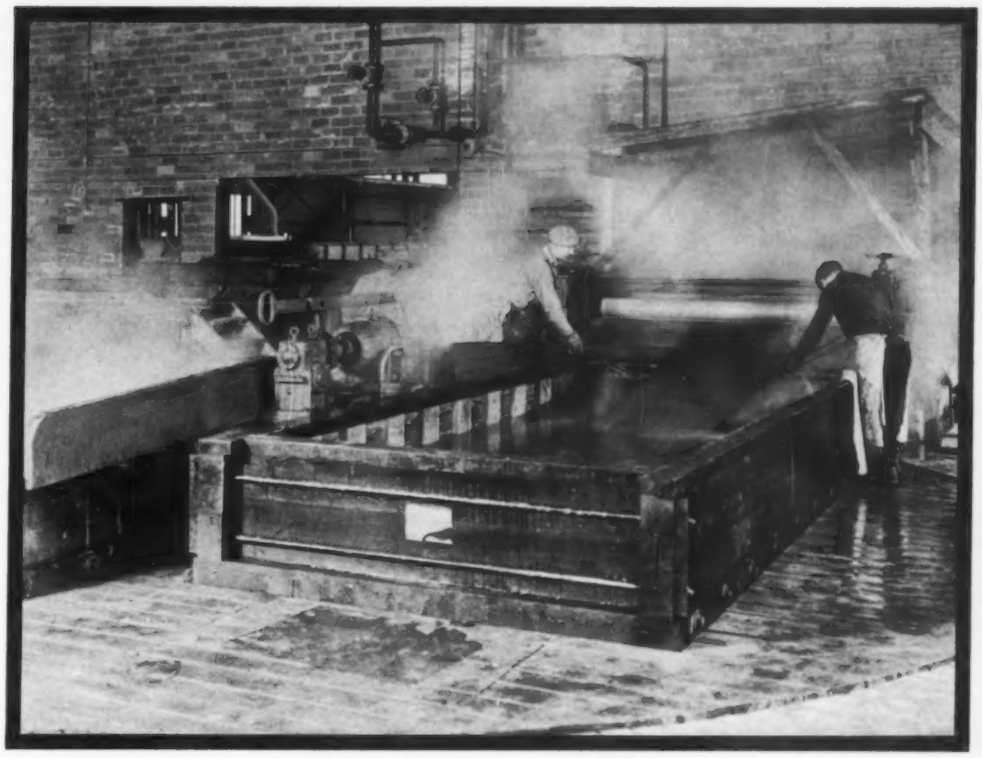
Thousands of pieces of moving machinery in the hot mill are dependent upon this oil pressure equipment for proper lubrication.





Normalizing furnace for hot rolled sheets, The roller table shown here keeps the sheets in continuous motion.

The finishing building taken from entrance to pickling room and looking toward the hot mill building.



These sheets are being removed from the water bath prior to being placed in the scrubbing and finishing line.

pumps, with gravity returns. Alarms are provided to warn of pressure failure in any of the systems. All electrical controls are completely interlocked.

A system to grease work roll bearings is also provided. The system is divided into three parts, one covering No. 1 stand and No. 1 scale breaker, and the other two covering No. 2 scale breaker and the remaining stands. This system is so arranged with grease pumps, motor operated valves and timing device, that a shot of grease is supplied to the stands at definite intervals.

Tables and auxiliaries of the entire hot mill are completely equipped with an automatic full pressure grease lubrication system. In addition, all miscellaneous machinery, levellers, trimmers, shears, etc., are equipped with hand-operated pressure lubrication systems. All cold mills are taken care of through three oiling systems, one of which takes care of the gear reducers of the 54″ and 75″ tandem mills, and skin pass mills; the second, of all cold mill back up roll necks; and the third, of drive and reel motors of the cold mills.

CRANES

To service the plant, thirty-two overhead traveling cranes and two Gantry cranes are installed, fully equipped with anti-friction bearings on all motors. The cranes are, as follows:

Location	No.	Capacity Tons	Span.	Lifting Magnet Controls
Slab yard	4	25/10	80′	4
Slab yard for slab chipping	2	7½	30′	2
Hot mill motor room	1	50/10	60′	
Hot mill motor room	1	20/5	60′	
Hot mill	2	60/20	82′6″	1
Plate finishing	2	15	100′	2
Hot strip finishing	2	25	100′	2
Hot strip finishing	1	25/15	100′	1
Blue annealing	3	25	100′	1
Scale pit	1	5	16′	
Machine shop	1	10	66′	
Continuous pickling	2	15	100′	2
Continuous pickling	1	25	100′	1
Box annealing	2	50/10	96′	1
Cold mill and roll shop	2	60/20	100′	
Cold mill	1	15	100′	1
Cold mill motor room	1	50/10	45′	
Processing building	2	15	100′	2
Shipping building	3	15	100′	1

The electrical equipment for the hot mills is on this long control panel which is situated in the basement under the motor and generator room.

LIGHTING

Power for lighting is furnished by the bank of transformers located in the hot mill motor room, previously described. This power at 440 volts comes through a 4000 amp. 3 pole air circuit breaker to three circuits of 3 phase, 1000000 CM weatherproof cable, which feed to various distribution points throughout the mill. At these points the 440 volt power is stepped down to 3 phase 110 volts by 10 KVA and 7½ KVA single phase oil insulated air cooled transformers, and distributed through sectionalized feeder circuits.

Overhead lighting consists of 300 porcelain enamel high bay units of 750 watts each, 225 silver backed glass reflectors with steel cases, of 750 watts each, and 325 prismatic glass reflectors with steel covers, of 750 watts each. These units are controlled by 215 two pole 60 amp., 110 volt breakers with no voltage release and overload protection.

Tunnel lighting consists of 210 units of 200 watts each, built into the side walls. Low bay lighting, control house lighting, pulpit lighting, etc., consist of over 700 units varying in capacity from 50 to 500 watts.

SERVICE DEPARTMENTS

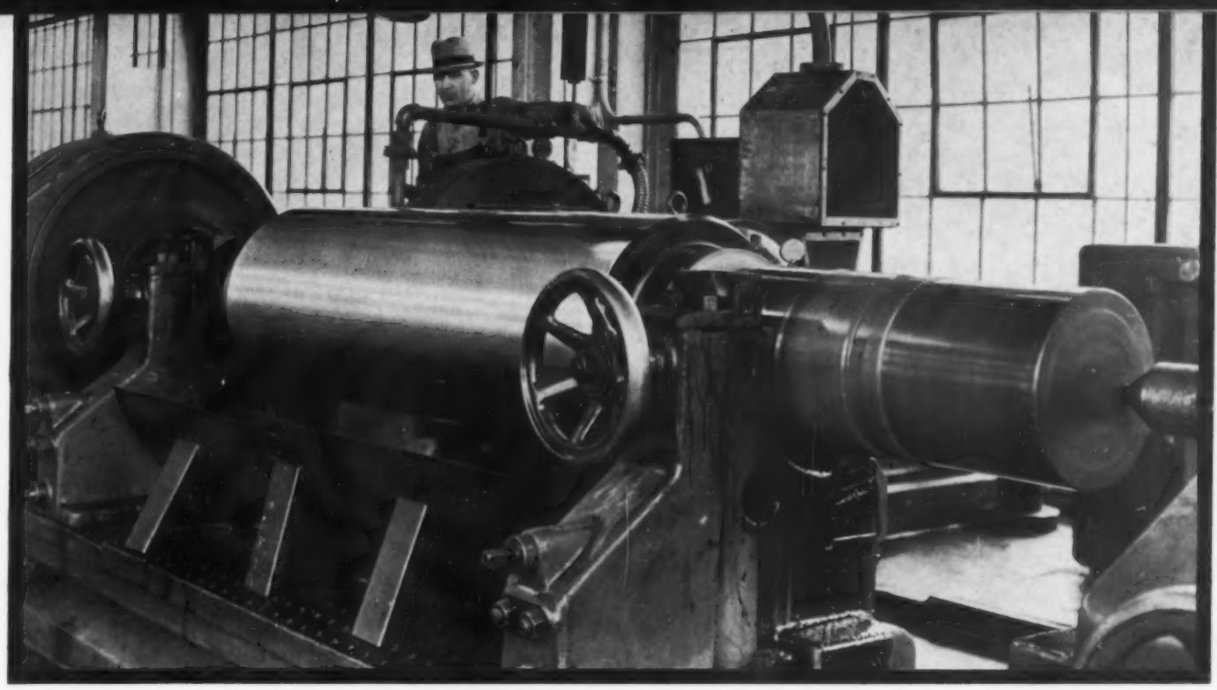
Due to the distance between the new strip mill and the original steel plant, it was deemed necessary to provide a new independent boilerhouse to furnish steam for process work and for building heating. The new steam plant is composed of four 500 H.P. boilers, of bent tube, six drum type, with superheaters and integral economizers. The boilers are designed for 200% rating, with working conditions of 150 lb. pressure and 200 degrees F. superheat. They are equipped with chain grate stokers, and designed to burn coke breeze or bituminous coal, which descend in gravity chutes from overhead bunkers. All boilers are equipped with steam purifiers, continuous blow downs, combustion control, and instruments. Instruments are mounted in a control room on the operating floor.

Auxiliaries for three of the boilers are steam driven, while those of the fourth are electrically driven. This gives protection against power failure, and at the same time supplies exhaust steam for feed water heating. Feed water is supplied from a hot process treating system, consisting of chemical mixing and proportioning equipment, reaction and settling tank, filters, and deaerating heater. The capacity of the treating system is 16000 gal. per hour, and that of the heater, 24000 gal. per hour.

Fuel handling is accomplished from hopper cars to overhead bunkers holding a twenty-four hour supply by a fully automatic skip hoist, belt conveyor, and tripper. Ash is discharged from the hoppers under each boiler directly into railroad cars shoved under the operating floor, which was elevated 22′ above ground for this purpose.

Both forced and induced draft fans are installed, the latter including a dust eliminator and collector. Three 2200 c.f.m. air compressors are also located in

Rechecking the strip for accuracy of gauge as it leaves the tandem cold mills.



One of four roll grinders for keeping the rolls in order.

the boilerhouse, and supply air at 100 lb. pressure for general use. Two are electrically driven, one steam driven.

Three service shops are located at the strip mill: A roll shop, a machine shop and an electrical shop. The roll shop is located in a well lighted building, designed as a continuation of the cold mill building. The shop is equipped with two 53″ x 20′, and two 36″ x 18′ roll grinders, as well as a grit blasting machine for special finishing of cold mill work rolls. The shop serves both the hot mill and the cold mills. Convenient to both hot and cold mills is the maintenance shop, a building 60′ x 175′, of brick and steel construction, in which are located electrical service department, store-room, small machine tools, welding machines, shear knife grinders, etc.

Water for the entire strip plant is supplied at the rate of 25,000,000 gallons a day, through a 36″ main nearly two miles long from the pumping station at the main steel plant.

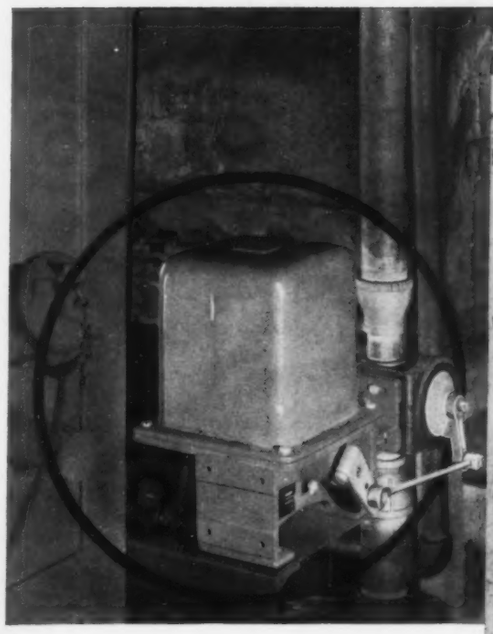
Hydraulic water for scale removal is supplied from two 6 stage centrifugal pumps, each designed for 1200 g.p.m. at 1000 lb. pressure, and driven by 1000 H.P. 6600 volt, 720 R.P.M. wound rotor induction motors. The spray valves, moved by double acting solenoids, can be operated either by load relays, or hand control from the pulpits. Control for the spray pump motors is so arranged that if one motor is in operation and the other is to be started, the outlet valve to the spray line cannot be opened until the pump has built up the pressure behind the valve equal to the pressure of the system. This is necessary to prevent a back pressure on the pump that is starting before it reaches full speed.

Warehouse and shipping building located in cold mill department. Here the sheets are made ready for shipment.

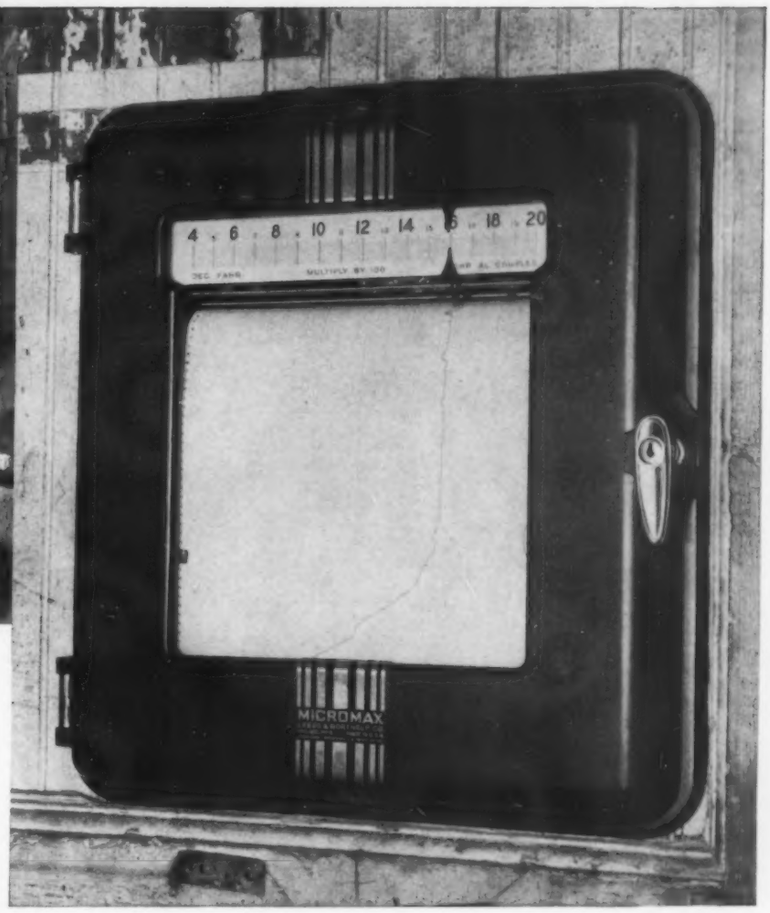
SUMMARY OF CONNECTED LOAD

	K.V.A.
No. 1 Scale Breaker	
1000 H.P., 86.5% P.F. x .746	860
No. 1 Stand	
3000 H.P., 84% P.F. x .746	2650
No. 2, 3 and 4 Stands	
3 x 3000 H.P., 92.5% P.F. x .746	7260
Finishing Mill—2 x 7200 KVA	14400
Spray Pumps—2 x 1000 H.P., 92% P.F. x .746	1640
Auxiliary M.G. sets—two 1500 K.W. sets	4200
Cold Mill M.G. sets—6000 K.W. set	7200
2500 K.W. set	3110
1300 K.W. set	1660
Three—1000 K.V.A. power transformers	3000
Three—500 K.V.A. light transformers	1500
Combined 6600 volt connected load	47480

Home of the administrative staff, metallurgical and shipping departments. The first aid facilities are also housed here.



Above—Note the simplicity and compactness of Micromax Electric Control's Valve Drive in the circle.



Right—Directing the Control is this Micromax Recording Controller.

Dependable REGULATION WITH MICROMAX ELECTRIC CONTROL

In spite of sudden changes in amount of material heated, the temperature of a process is held constant within a few degrees by Micromax Electric Control. Promptly adjusting fuel to each minute change in temperature, the Control improves uniformity, makes for smooth, efficient operation.

Merely turning a rheostat changes the "throttling range" (the temperature change required to cause full motion of the valve) as much as is necessary to fit the Control to the individual process. There are no re-adjustments to linkages or gears. Even when large changes occur in the amount of material to be heated, the Control can be adjusted either manually or automatically to retain closest heat balance and consequently closest temperature control.

J-N00A(3)

LEEDS & NORTHRUP COMPANY
4942 STENTON AVENUE PHILADELPHIA, PA.

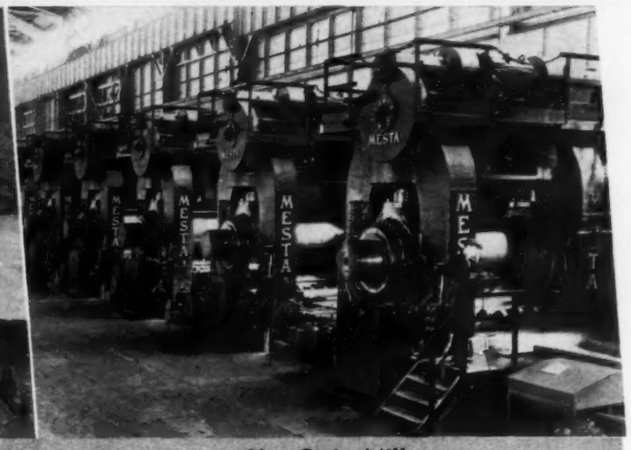
LEEDS & NORTHRUP

MEASURING INSTRUMENTS - TELEMETERS - AUTOMATIC CONTROLS - HEAT-TREATING FURNACES

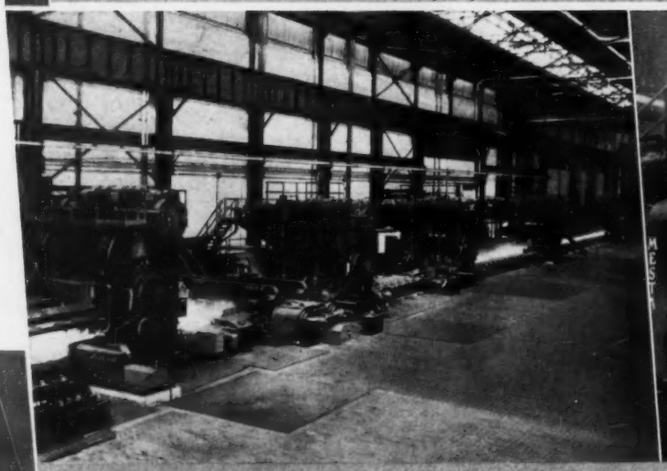
BUILT BY

MESTA MACHINE COMPANY

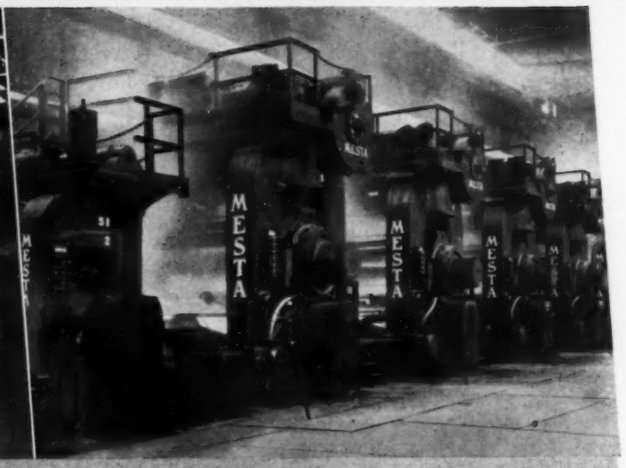
Slabbing Mill
Inland Steel Company



Hot Strip Mill
Inland Steel Company

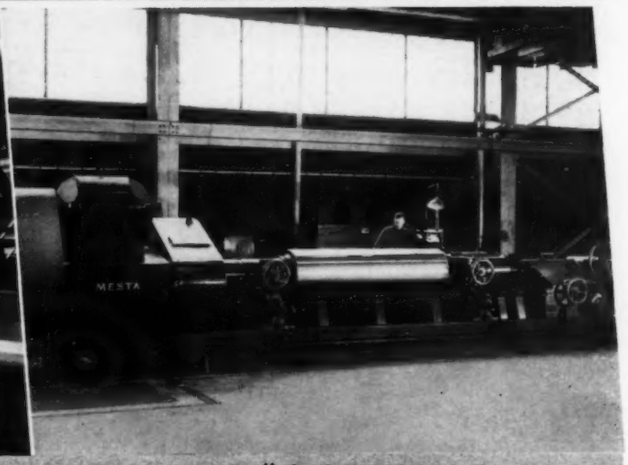


Hot Strip Mill
Great Lakes Steel Corp.



Hot Strip Mill
Youngstown Sheet & Tube Co.

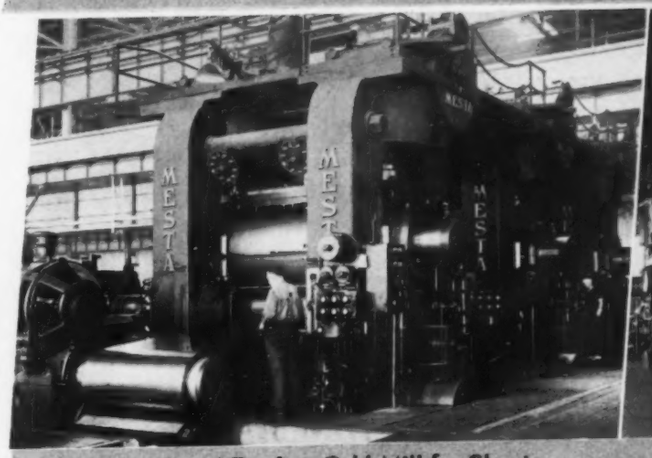
Hot Strip Mill
Wheeling Steel Corp.



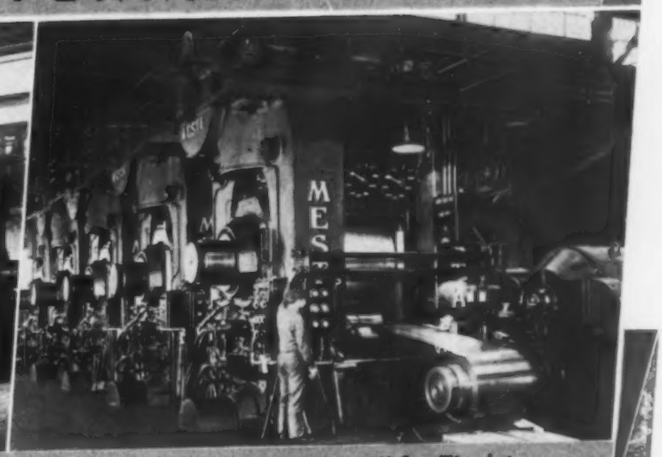
60" Roll Grinder
Jones & Laughlin Steel Corp.

MESTA

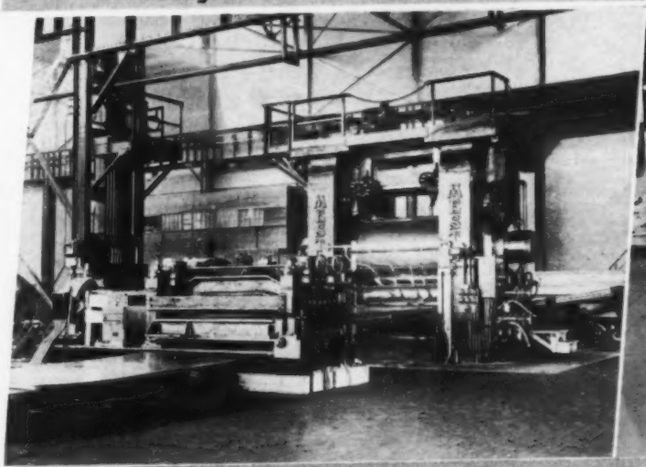
PITTSBURGH, PENNA.



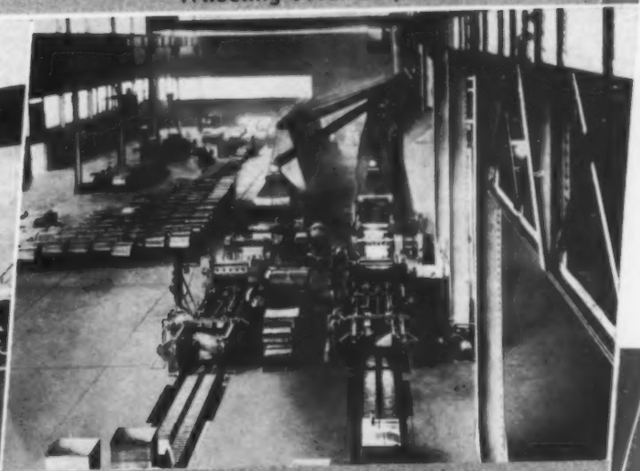
Three Stand Tandem Cold Mill for Sheets
Youngstown Sheet & Tube Co.



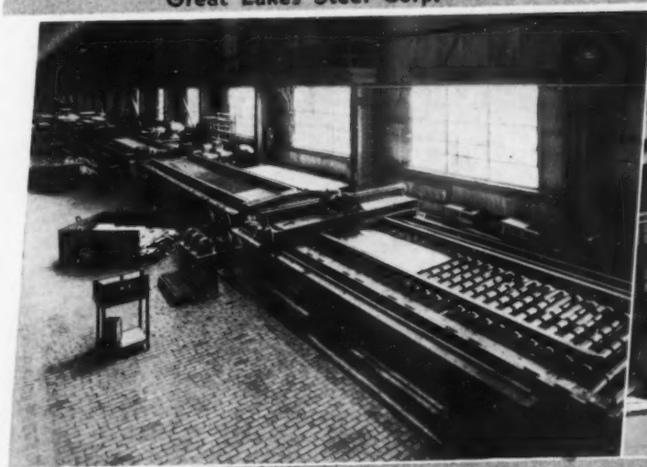
Five Stand Tandem Cold Mill for Tinplate
Wheeling Steel Corp.



Single Stand Cold Mill for Sheets
Great Lakes Steel Corp.



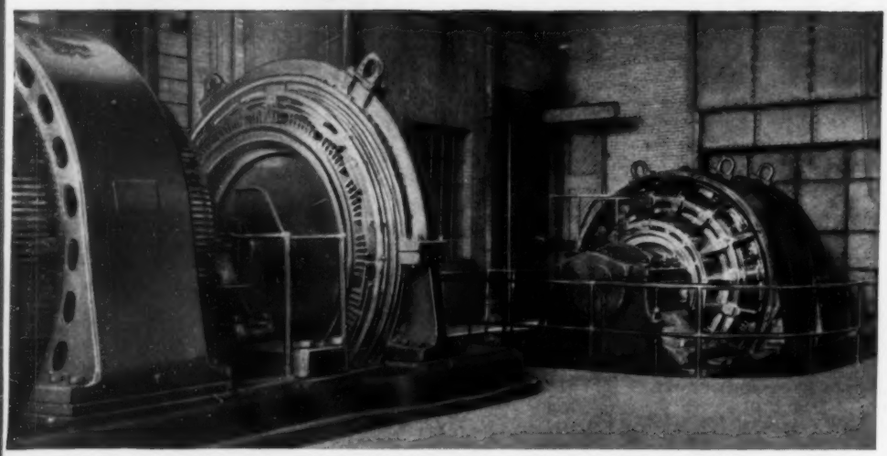
Electro-Cleaning Lines Including Mesta
Patented Flying Shears for Tinplate
Weirton Steel Company



Levelling, Trimming and Up-Cut Shearing Line
for Blue-Annealed Sheets
Great Lakes Steel Corp.

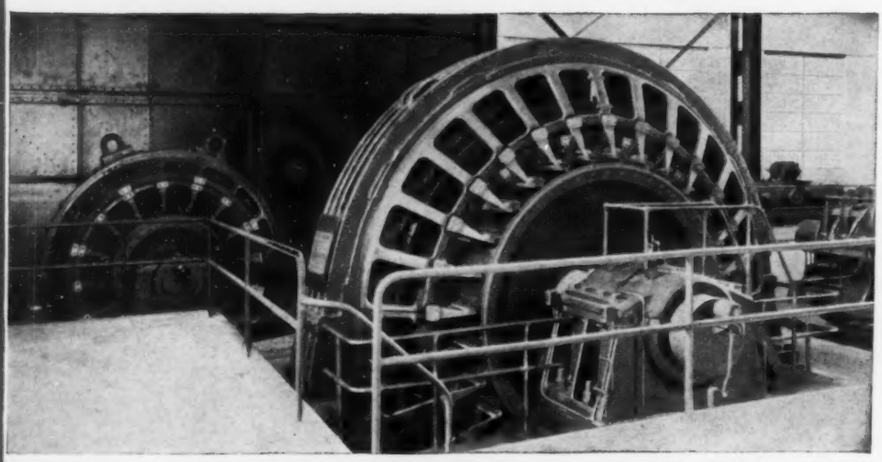
Trimming, Levelling and Rotary
Shearing Line for Cold Strip
Youngstown Sheet & Tube Co.

20 YEARS OF PROGRESS



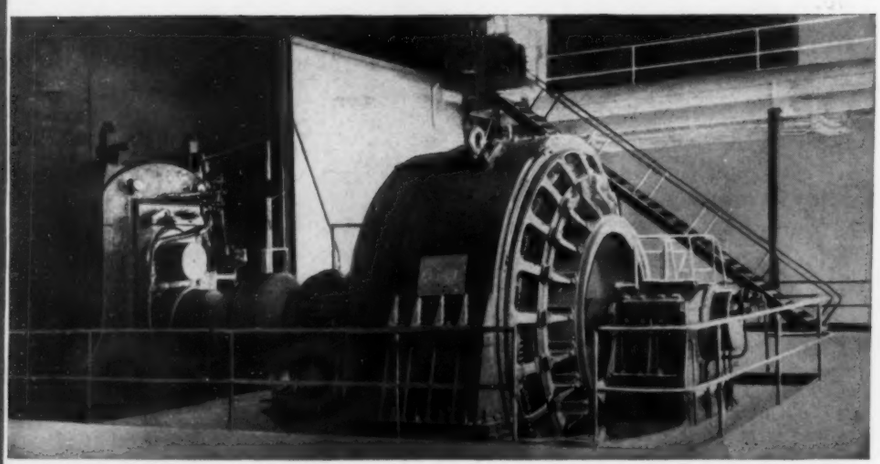
1917 FIRST REVERSING MOTOR DRIVE

This G-E reversing motor was chosen to drive the finishing train of the rail mill —the first reversing mill in the plant. It proved so reliable that today a total of 44,000 hp in G-E reversing main-roll drives is used.



1926 24,000 HP IN REVERSING MOTORS

When it was decided to install the first electrically driven wide-flange beam mill in the world, G-E engineers were asked to solve the many new drive problems involved. Highly satisfactory operation of the whole mill has resulted. A total of 24,000 hp in G-E reversing motors, of which two are shown, is used.



1928 MODERNIZATION OF RAIL ROUGHING TRAIN

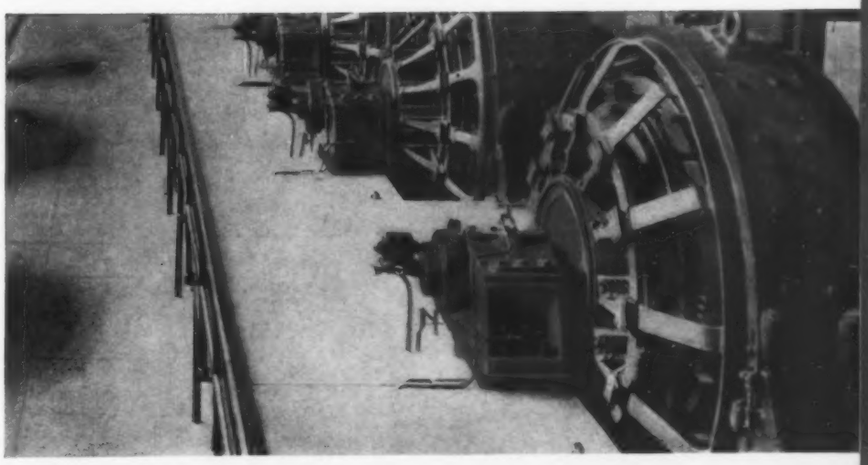
This 5,000-hp G-E motor was installed on the roughing train of the rail mill to supplant the steam drive that had been used. More passes per minute result from the higher rate of acceleration and deceleration made possible by electric equipment.

G E N E R A L

IN ONE STEEL PLANT

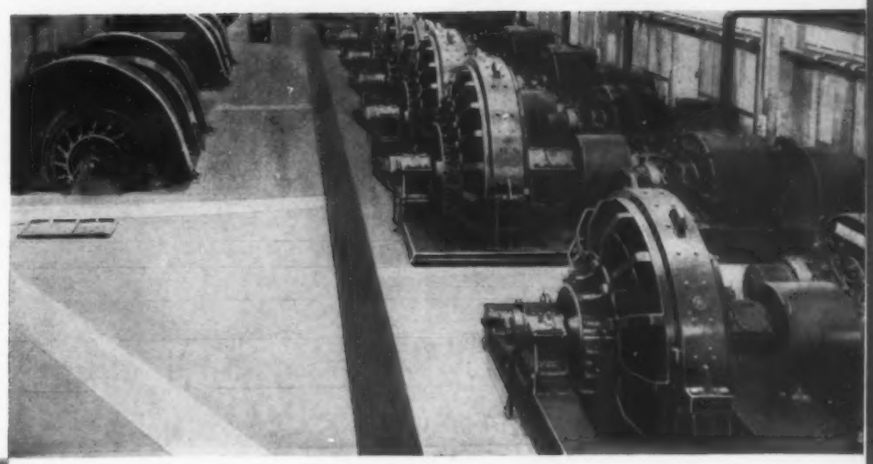
1930 FIRST RECIRCULATING VENTILATION

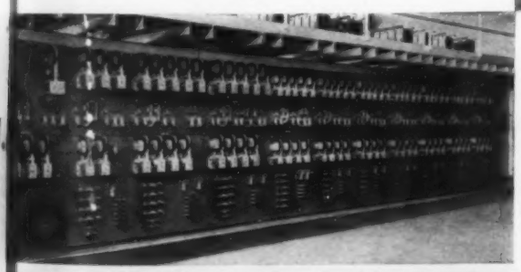
The *first* motor room employing recirculating ventilation with surface coolers. The G-E motors on the 21-inch sheet-bar mill are shown at right. Recirculating cooling keeps electric apparatus cleaner than does any other system of ventilation.



1935 BROAD-STRIP PRODUCTION STARTED

Toward the last of the year, the 79-inch continuous hot-strip mill went into operation. Six adjustable-speed G-E motors, fed by G-E motor-generator sets (left of picture) drive the finishing stands. Trouble-free operation and precision control help in meeting the exacting requirements for hot strip.





For many years G-E control has been standard in the plant. Shown (left) is a control board, equipped with the long-lived rocker-bearing contactors, for controlling auxiliary drives in the hot-strip mill.

G-E metal-clad, 6600-volt switchgear in the motor room shown above. Equipped with the famous FKR-255 oil-blast circuit breakers, this switchgear provides greater continuity of operation and greater safety to operators.

FOR YOUR MILL

WHATEVER *your* needs for electric equipment, our engineers will help you get the apparatus that will exactly meet the requirements of your mill. The same service is yours, regardless of the size of your mill or of your company. Call the nearest G-E office or write General Electric Company, Schenectady, New York.

GE

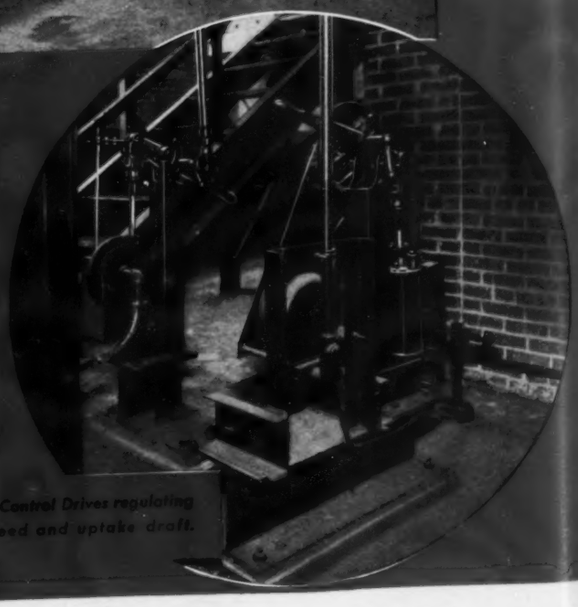
E L E C T R I C

STEEL MAKES STEAM *with an*

Boiler Control Panels including Bailey Boiler Meters as an integral part of the Bailey Combustion Control System installed on four 500 h. p. stoker-fired boilers in a Steel Mill Power Plant.

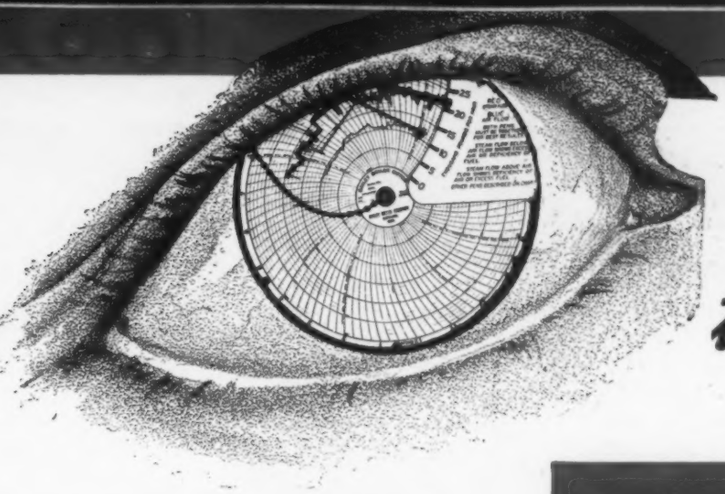
OTHER BAILEY PRODUCTS FOR THE STEEL INDUSTRY

- FURNACE DRAFT CONTROL
- FUEL—AIR RATIO CONTROL
- ATMOSPHERE CONTROL
- PRESSURE CONTROL
- GAS MIXING CONTROL
- GAS FLOW METERS
- STEAM FLOW METERS
- AIR FLOW METERS
- WATER FLOW METERS



Bailey Control Drives regulating fuel feed and uptake draft.

BAILEY METER CONTROL



...an Eye to Economy

BAILEY METER CONTROL *Continuously Maintains Test Results in Everyday Operation*

• To secure day-by-day operating efficiencies equal to those obtained under test conditions is the goal of every power plant engineer. It is by such operation that investments in boiler room modernization are made to pay handsome dividends.

Steam Flow—Air Flow Boiler Meters are an integral part of the Bailey Combustion Control System. These eyes to economy see combustion changes as they occur and automatically operate the control, readjusting fuel feeds as required to obtain optimum combustion conditions in each boiler furnace.

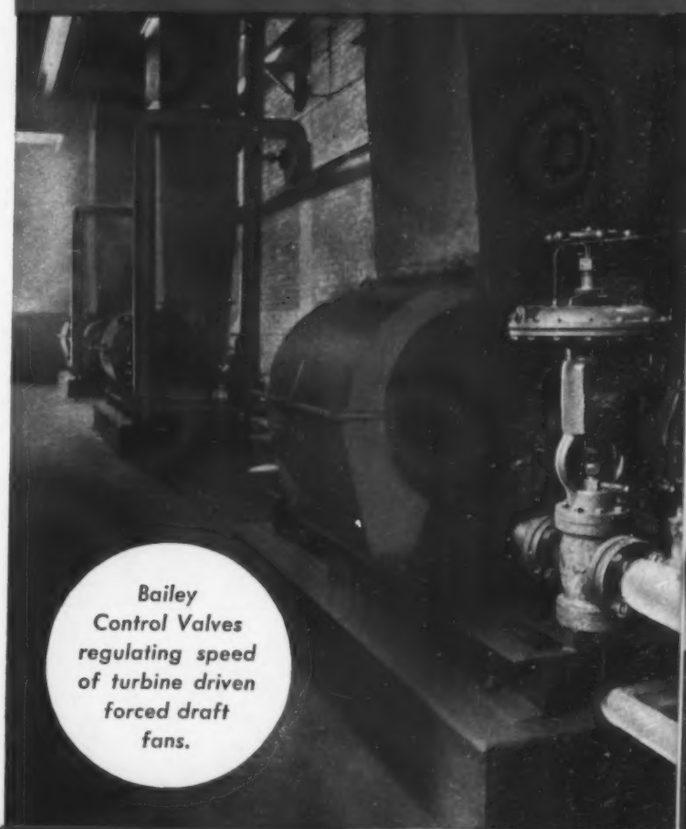
Bailey Meter Control makes possible the maintenance of boiler test standards in everyday operation because it is a complete system which (1) automatically maintains desired steam pressure; (2) automatically maintains most economical fuel—air ratio; (3) automatically maintains desired furnace draft; (4) automatically maintains division of load among boilers.

Detailed information on this sturdy, inexpensive air-operated control system is contained in Bulletin No. 102-A. Your copy will be mailed without obligation upon request.

BAILEY METER COMPANY
1047 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada 5-6

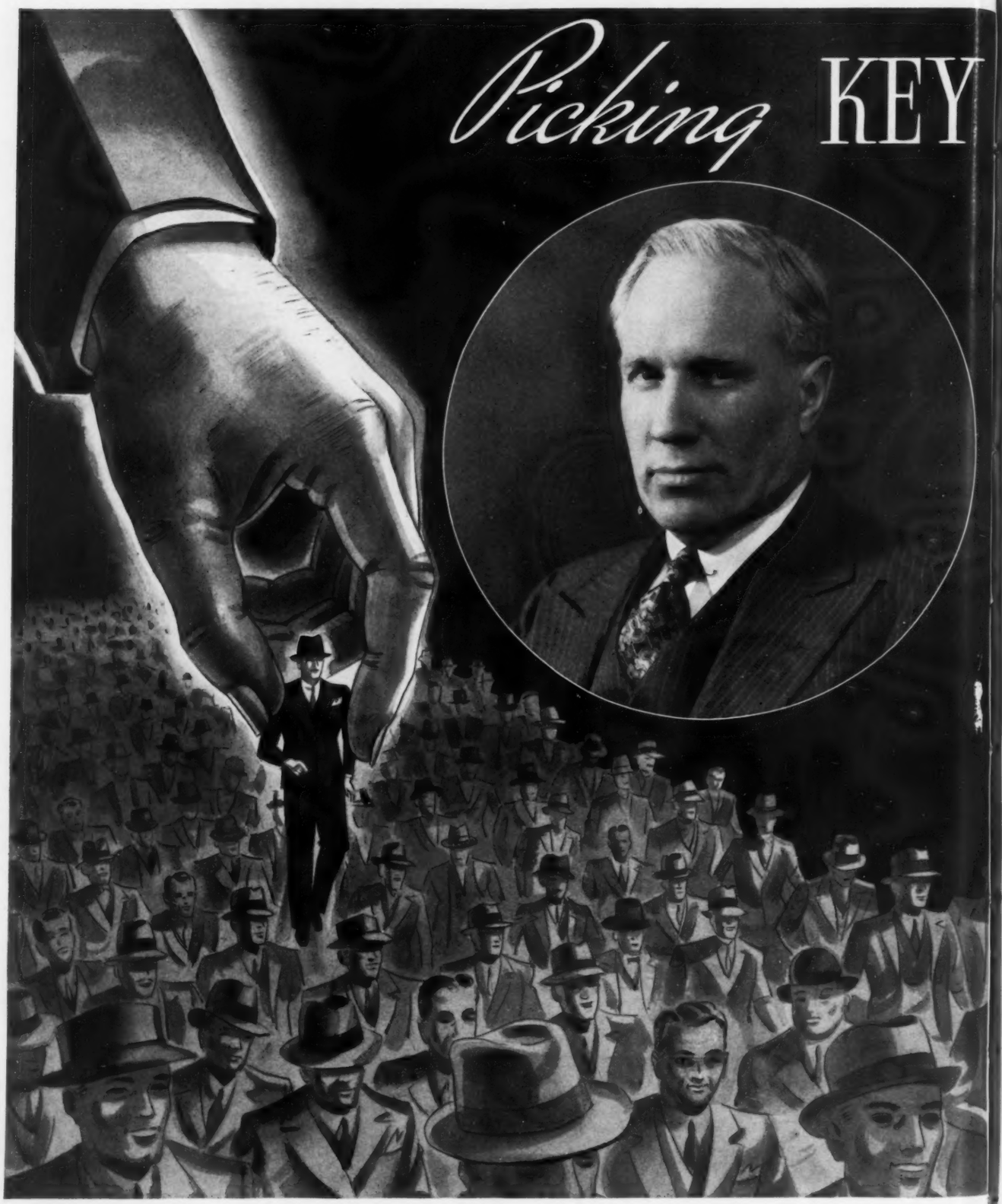
A FEW OF THE MANY STEEL COMPANIES USING BAILEY METERS

Allegheny Steel Company
American Rolling Mill Company
American Sheet and Tin Plate Co.
American Steel and Wire Co.
The Andrews Steel Company
Bethlehem Steel Company
A. M. Byers Company
Carnegie-Illinois Steel Corp.
The Colorado Fuel & Iron Co.
Empire Sheet & Tin Plate
Great Lakes Steel Corp.
Gulf States Steel Company
Jones and Laughlin Steel Corp.
Lukens Steel Company
The Midvale Company
National Tube Company
Oliver Iron & Steel Corp.
Pittsburgh Steel Company
Reading Iron Company
Republic Steel Corporation
Sharon Steel Hoop Company
Tennessee Coal, Iron & R. R. Co.
Union Drawn Steel Company
Weirton Steel Company
Wheeling Steel Corporation
The Youngstown Sheet & Tube Co.



Bailey Control Valves regulating speed of turbine driven forced draft fans.

The **COMPLETE** *Combustion Control System*



Since 1906, when he was the original and one-man sales force, Mr. Hitchcock has been an enthusiastic worker for the success of Reliance as an organization—and always with a keen interest in the accomplishments of its individual members.

MEN *at* RELIANCE . . .

The most interesting work ever allotted to me is heading up the job of finding good men to be added to our organization. At first it was not easy to attract the men who met the standards which we set up. Men of their caliber were in a position to do some choosing—they were not easily convinced that Reliance presented an opportunity. Today, new men find here a group with engineering training, those who like themselves have been leaders among their fellows because of ability and because they are agreeable associates. Men like these have found opportunities at Reliance because they are always making them—by seeking ways for Reliance to design better motors, build them better, and to apply them in ways that bring faster production or improved quality. Key men of this type serve Reliance customers from sales through manufacturing.

—H Morley Hitchcock

Sales Vice-President and Treasurer

This enclosed fan-cooled d-c. motor is representative of results achieved at Reliance in producing motors that will stick to their work longer where there's dirt, iron dust, oil or moisture. By preventing, it avoids "fixing." These motors provide the advantages of adjustable speeds in sizes up to 150 hp. Space is conserved, since in most cases the same horsepower and speed ratings are developed as by open motors of the same frame size.

★ ★ ★

In supplying motor-drives for roll grinders Reliance is accustomed to pleasing two particular parties . . . the machinery builder and the user. Only with an accurately-built, perfectly-balanced motor can the grinder produce on the rolls the mirror finish so necessary for rolling sheets of uniform gauge . . . Three fan-cooled d-c. adjustable-speed Type T Heavy-duty Motors and three constant-speed motors are used on the roll grinder shown herewith.

At our branch offices are capable Sales Engineers trained in the application of electric motors.

RELIANCE ELECTRIC & ENGINEERING COMPANY

1088 IVANHOE ROAD • CLEVELAND, OHIO

Branches: BIRMINGHAM • BOSTON • BUFFALO • CHICAGO • CINCINNATI
DETROIT • GREENVILLE (S. C.) • NEW YORK • PHILADELPHIA • PITTSBURGH

Representatives in Other Principal Cities

Enclosed Fan-cooled D-c. Type "T" Reliance Motor.

Farrel-Birmingham Roll Grinder equipped with six Reliance D-c. Motors.

RELIANCE A-C D-C **MOTORS**

There are 36 SC HORIZONTAL ra

ANNEALING COVERS IN USE IN THIS MO

sheet and strip mill at the Lackawanna plant

AL *radiant tube*

HISMODERN

ast

● All that steel men learned from generations past, all that they know today went into the building and equipment of this modern new sheet and strip mill. Among the important installations for production were 30 SC Horizontal gas-fired *Radiant Tube* Annealing Covers. Recently six more were added as mill capacity was taxed. Today these 36 SC units are handling the entire production of this great mill with outstanding efficiency as to high speed of production, uniform quality of product and economy of maintenance and operation.

Invariably SC Annealing Covers deliver the highest quality of work at the lowest cost per ton annealed—a fact proven many times over during the past three years. Longer gas travel, greater heat transfer, precision and ease of control—all advantages are directly traced to SURFACE COMBUSTION engineers' experience in building steel mill equipment for practical and economical production.

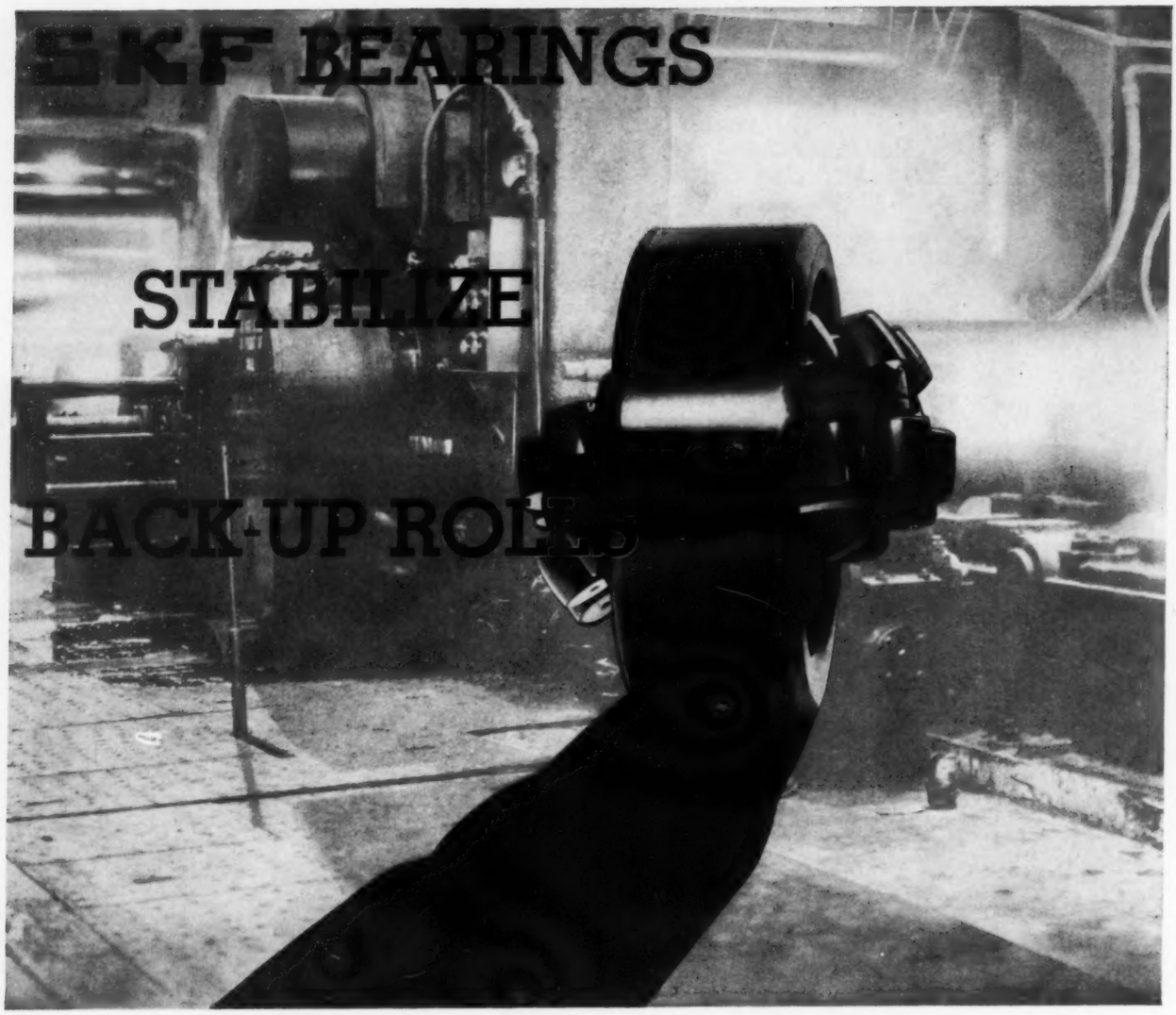
From top to bottom, and end to end, SC Horizontal gas-fired *Radiant Tube* Annealing Covers permit an exactness of control in the heating zone that has no counterpart in fuel efficiency and uniformity. SC floating tube construction eliminates distortion or stress in tubes from expansion under heat, maintaining full efficiency, and avoiding expensive maintenance.

SC gas-fired *Radiant Tube* Annealing Covers, round and rectangular types, are available in standard sizes for coil, strip and sheet requirements. An SC Engineer will call without obligation to give you facts and figures if you like.

SURFACE COMBUSTION CORPORATION...Toledo, Ohio

SURFACE COMBUSTION

Builders of... ONE WAY FIRED SOAKING PITS, BILLET HEATERS, PACK OR PAIR, ANNEALING, CONTROLLED ATMOSPHERE FURNACES, NORMALIZERS



WHEN you're on the inspection trip at the April meeting of the Association of Iron and Steel Engineers, pay particular attention to back-up rolls. You will find that Mesta has stabilized them with SKF Self-Aligning Spherical Roller Bearings.

Mesta knows that the built-in alignment of SKF Bearings permits the use of simplified housings . . . that SKF are self-contained to assure quick mounting without set-up adjustment, and never need correction for wear. By using SKF Bearings, they make certain of increased tonnage at the lowest cost per bearing hour. Send for catalog, "SKF Rolling Mill Data for Calculation and Design." SKF INDUSTRIES, INC., Front St. & Erie Ave., Phila., Pa.

3858

ROLLER SKF BEARINGS

Look for this mark on the switchgear of the modern steel mill!

Were A. I. & S. E. members to visit all recently constructed steel mills, they could scarcely help noting the prevalence of I-T-E circuit breakers.

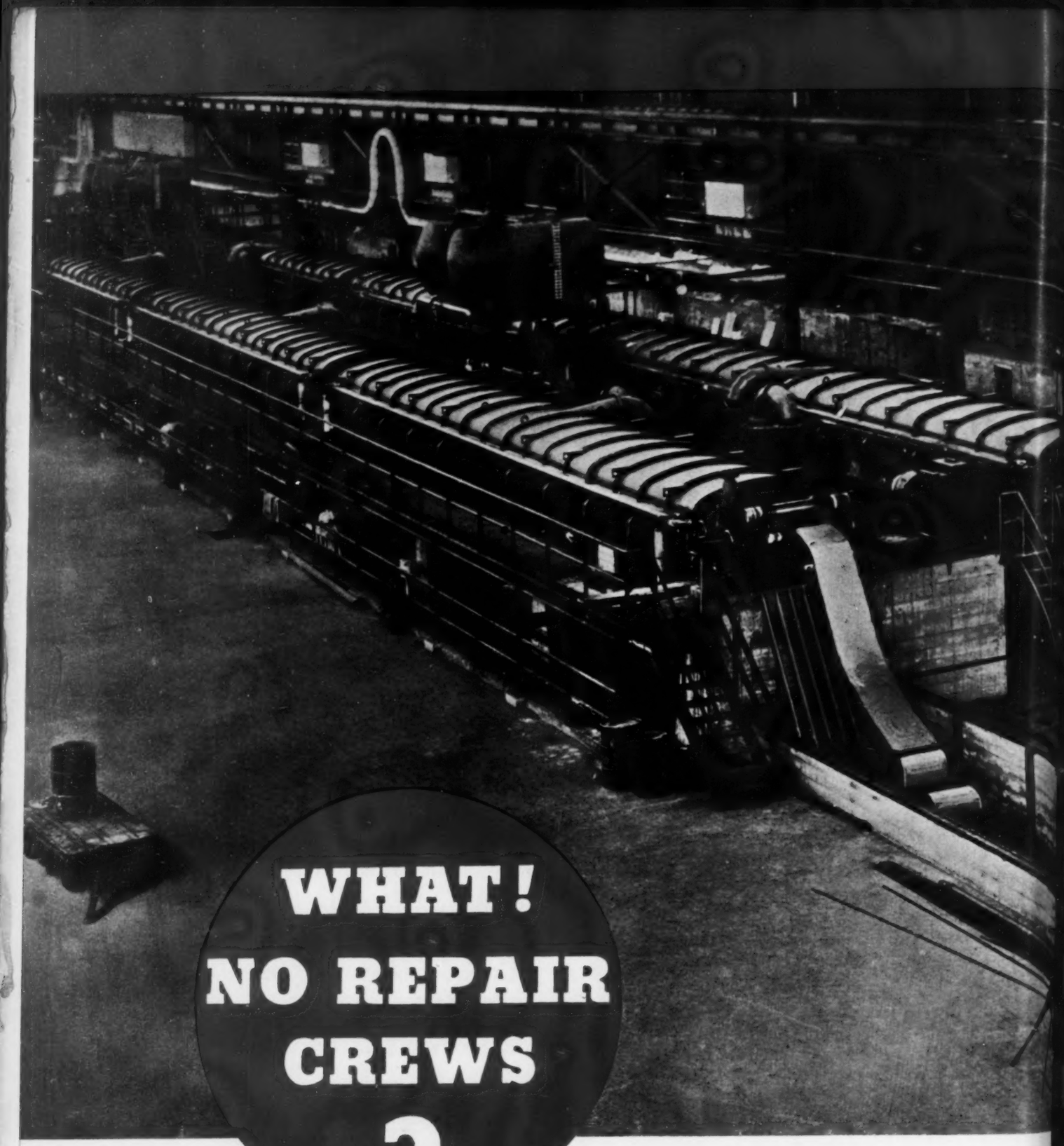
The reason is not far to seek. I-T-E engineers accepted modern steel mill practice as a separate protective problem and designed new circuit breakers especially for the work.

In addition to circuit breakers, I-T-E improvements include complete switchboards and bus structures.

Our engineers will be glad to give you a complete outline of I-T-E progress in the steel-mill field.

Representatives in Principal Cities

I-T-E Circuit Breaker Co., Philadelphia



WHAT! NO REPAIR CREWS ?

Two modern continuous pickling lines with Goodrich tanks and tank covers. Sixteen such lines are in operation, with nine more under construction.

HERE'S a modern pickling room in full blast. No repairmen patching leaks, no acid pools on the floor, no acid seeping through the ground to undermine building foundations, no shut-downs for repairs.

These are Goodrich Tanks. Hundreds of similar Goodrich Tanks are in successful use—many have been operating for five years without a penny of repair expense.

Goodrich engineers developed every basic feature of the modern pickling tank. These same engineers will be glad to work with you, to engineer these proven tanks to your operation. The B. F. Goodrich Company, Mechanical Rubber Goods Division, Akron, Ohio. (In Canada: Canadian Goodrich Company, Ltd., Kitchener, Ontario.)

Goodrich

ALL product problems IN RUBBER

It takes more than THEORY to build a Transformer

Advanced Theory

+

Practical Construction

+

Experience and Research

+

Intelligent Engineering

+

Careful Selection of Materials and Parts

+

Skilled Workmanship

+

Competent Supervision

+

Proper Facilities for Manufacture

+

Efficient Management

=

Wagner 4000-kva, 60-cycle, 69000 to 2400 volt, single-phase power transformer equipped with special oil-filled high-voltage bushings.

Why Wagner Transformers are Good!

It will pay you to investigate Wagner transformers. Write today for literature.

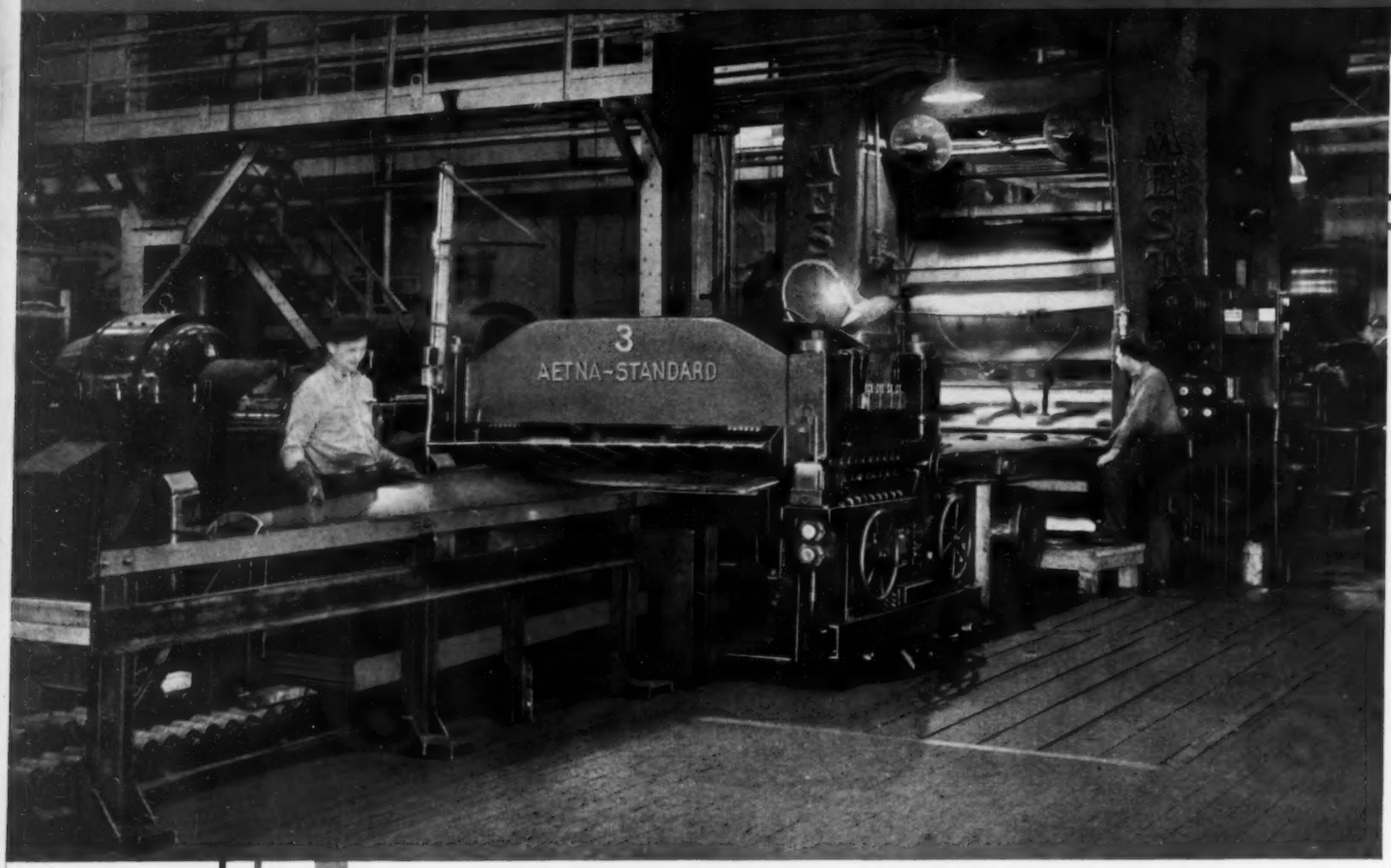
Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, U.S.A.

TP 137-1B

TRANSFORMERS • MOTORS • FANS • BRAKES

"CHATTERMARKS"
NO LONGER A PROBLEM



Five BACKED-UP ROLLER LEVELLERS designed and built by THE AETNA-STANDARD ENGINEERING COMPANY for use in the Cold Strip Sheet Mill of The Youngstown Sheet and Tube Company, have conclusively proven that wide strip sheets can be precision levelled at high speeds WITHOUT CHATTER.

More than forty Aetna-Standard Backed-Up Levellers are in successful operation in the steel and automobile industries . . Consult our Sales Engineers for further information on this subject.

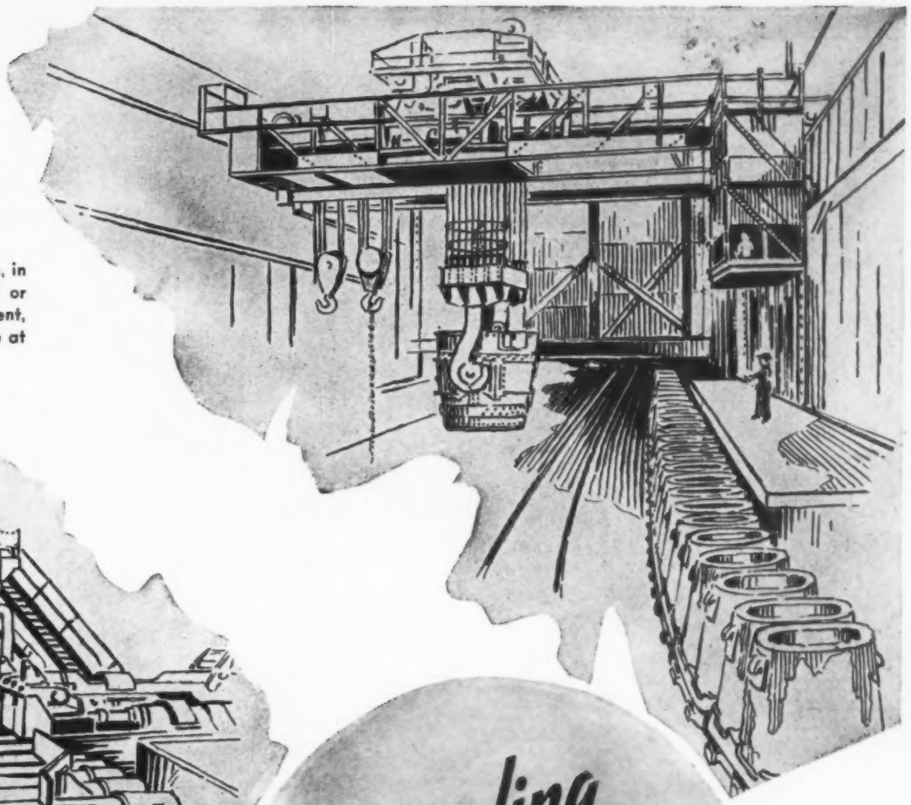
THE AETNA-STANDARD ENGINEERING COMPANY

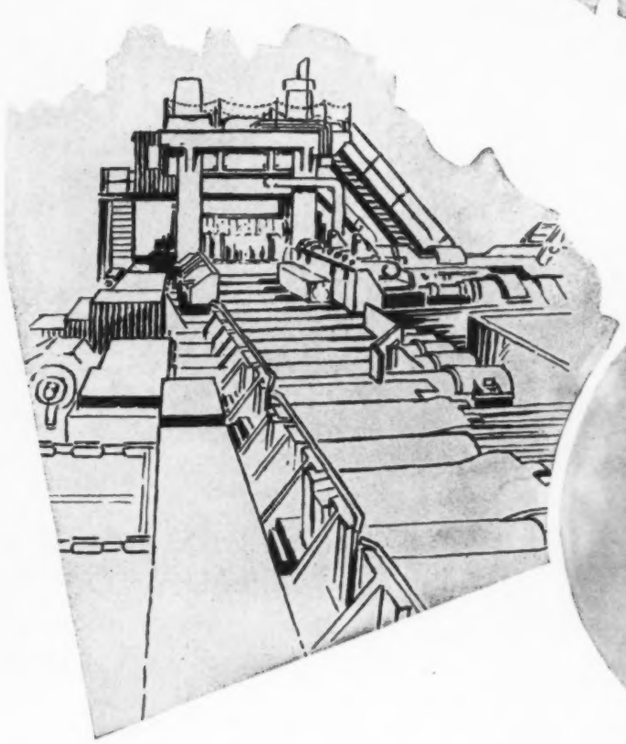
CONSULTANTS · DESIGNERS · BUILDERS

STEEL AND NONFERROUS INDUSTRIES

YOUNGSTOWN « OHIO » U.S.A.

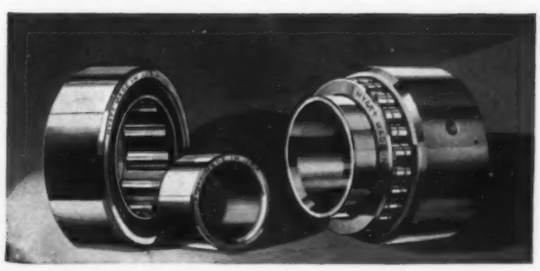
If you have any bearing problem, in the machines you manufacture or in your own operating equipment, Hyatt plant and field forces are at your disposal.





Speeding PRODUCTION TOWARDS NEW ECONOMIES

HYATT
ROLLER BEARINGS

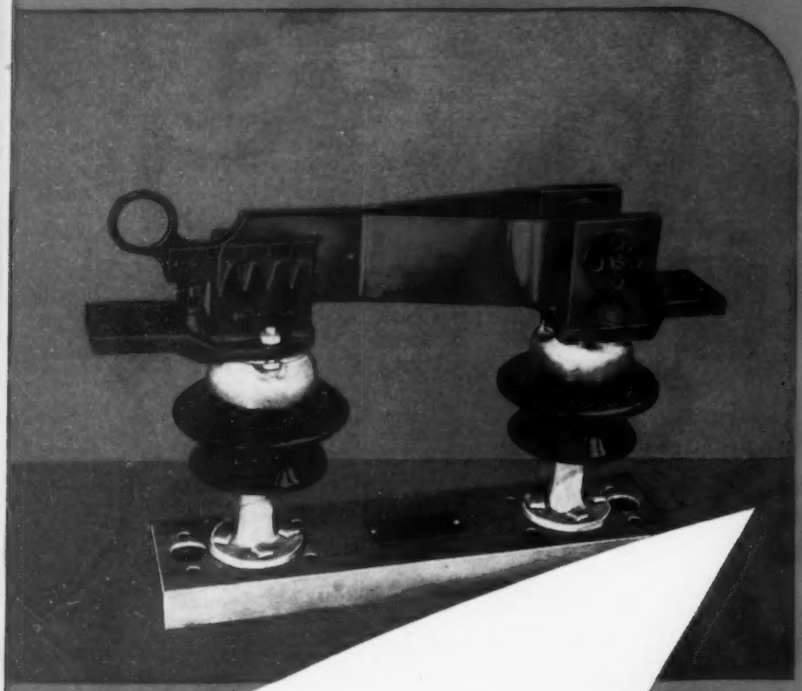


TODAY'S insistent demand for dependability in modern steel mill equipment is capably met by the indisputable advantages of fine workmanship and fine materials that identify every Hyatt Roller Bearing.

Built of the strongest bearing steel it is possible to procure . . . machined to microscopic tolerances which bring precision to the highest possible degree . . . every Hyatt has the exceptional ability to assimilate the gruelling punishment imposed by heavy loads and high speeds, while maintaining a constant and correct alignment of related parts.

Used in tables, cranes, motors, cars or other auxiliary equipment, Hyatts offer almost limitless possibility for economy in design and operation. Hyatt Bearings Division, General Motors Corporation, Newark, Detroit, San Francisco. Hyatt Roller Bearing Sales Company, Chicago and Pittsburgh.

OUTDOOR



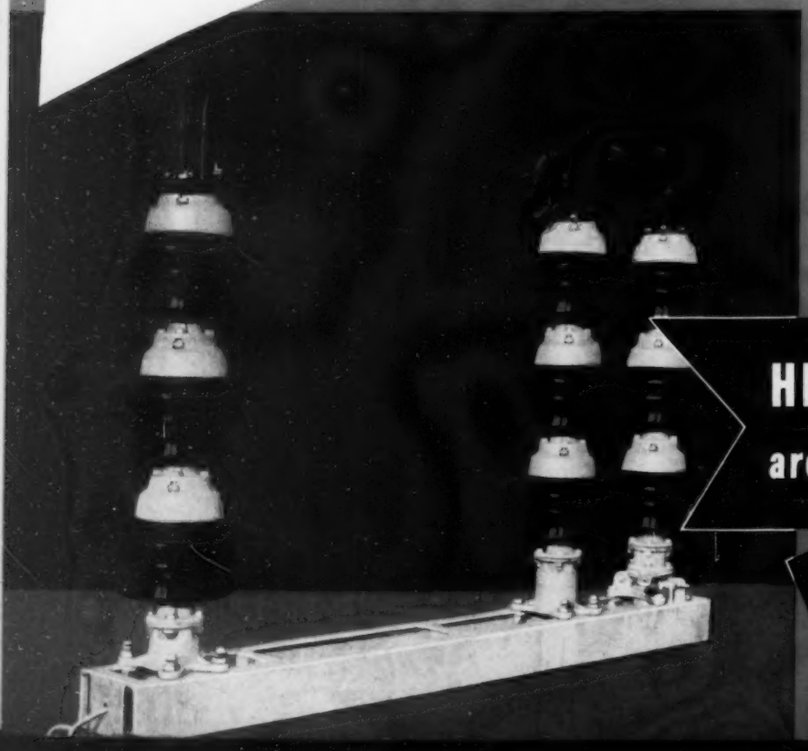
Hi-Pressure Contacts characterize all R. & I. E. switching equipment, and are accepted as the standard of comparison.

Not pressure alone, but pressure plus a wiping action insures clean and positive metal to metal contacts.

Check these R&IE

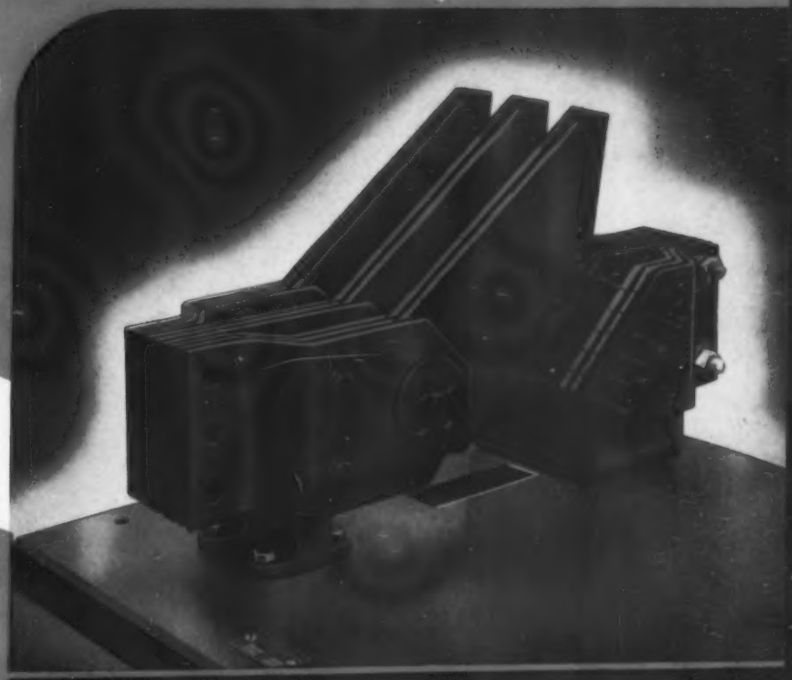
The small number of well proportioned parts contribute to the appearance of the complete layout when R. & I. E. Switches are installed.

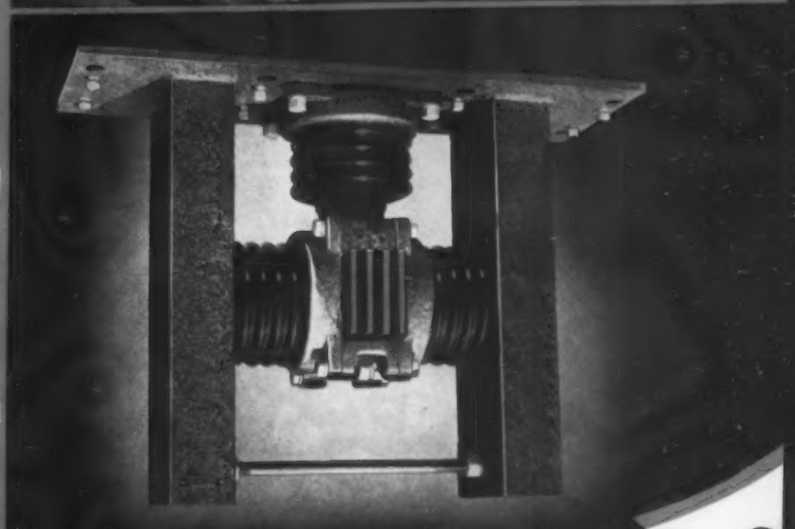
All outdoor switching equipment is built on N. E. M. A. standard insulator units. Slotted insulator caps assure easy assembly and interchangeability.



HI-PRESSURE CONTACTS
are an original development of the
RAILWAY and IN
GREE

INDOOR





R. & I. E. straight line construction (terminal to terminal current flow is through high conductivity rolled copper) is especially suitable for high capacity switching equipment.

advantages

Well ventilated Hi-Pressure spot and annular line contacts under pressure guarantee that high currents may be safely carried.

Annular ring contacts under pressure at hinge insures easy operation as parts in motion are positively sealed against dirt or corrosion.

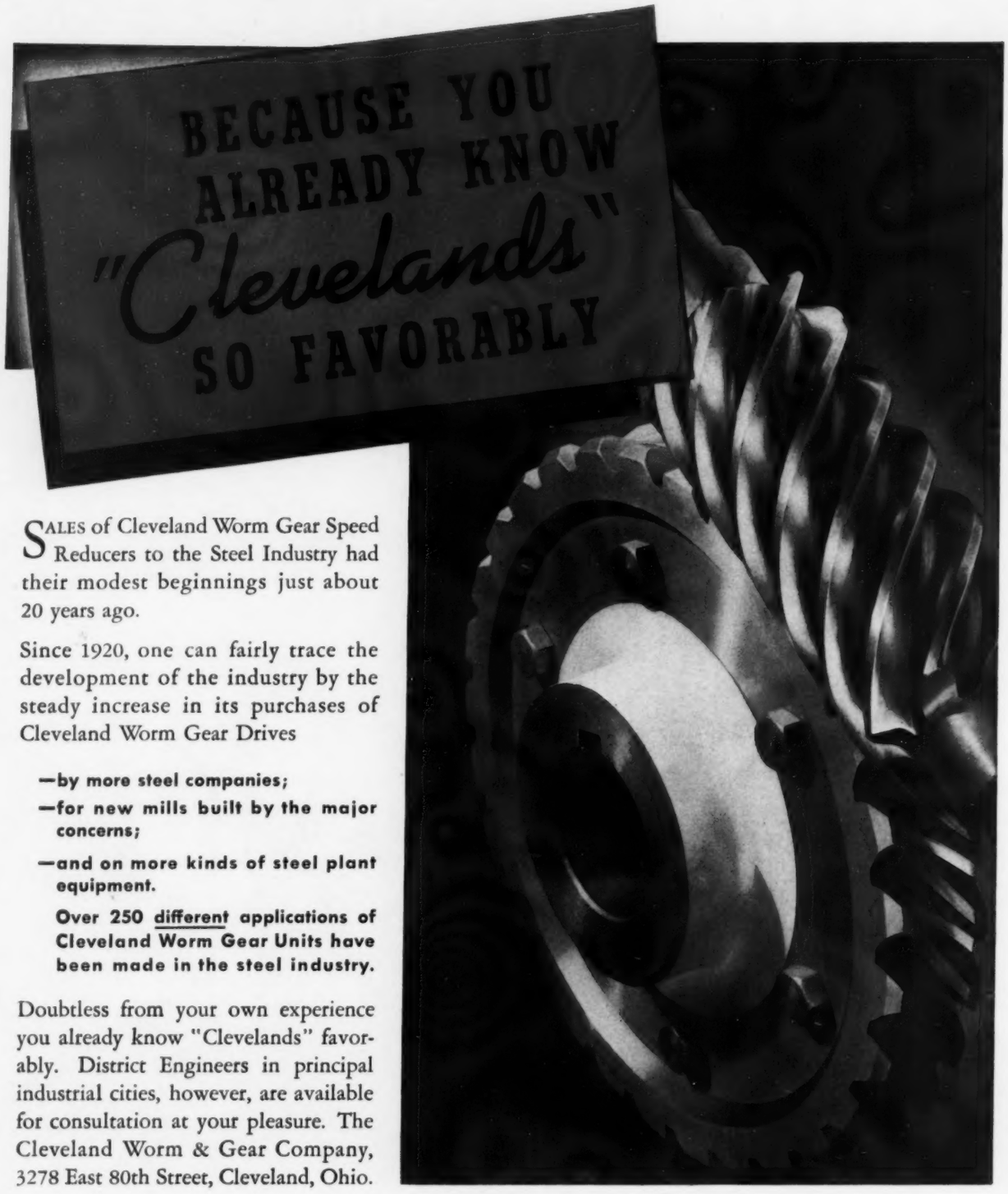
R. & I. E. manufactures a complete line of bus supports from the smallest to the largest. All are designed to meet your particular requirements.

Bus Supports illustrated were designed for heavy industrial and steel mill work. One for 6" copper bar, and the other for 12" aluminum channel.

You can see TODAY—what R.&I.E. switching equipment means to your service TOMORROW

INDUSTRIAL ENGINEERING CO.

GREENSBURG, PENNA.



SALES of Cleveland Worm Gear Speed Reducers to the Steel Industry had their modest beginnings just about 20 years ago.

Since 1920, one can fairly trace the development of the industry by the steady increase in its purchases of Cleveland Worm Gear Drives

—by more steel companies;

—for new mills built by the major concerns;

—and on more kinds of steel plant equipment.

Over 250 different applications of Cleveland Worm Gear Units have been made in the steel industry.

Doubtless from your own experience you already know "Clevelands" favorably. District Engineers in principal industrial cities, however, are available for consultation at your pleasure. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

★ CLEVELAND *Worm Gear Drives*

ANOTHER RECORD

of Superior Insulation Performance is Launched!

THE SOAKING PITS *in this modern continuous strip mill are protected against radiation losses by J-M Superex Blocks . . . used 4" thick on sidewalls and bottoms, 2½" thick over arches and flues.*

As MODERN as present-day engineering design and advanced equipment can make it . . . this newest of continuous strip mills.

Little chance of *any* material finding its way into such a mill without a proven record of lasting efficiency and economy under the most severe service conditions!

Hence, the selection of Johns-Manville's famous Superex Blocks for insulating the soaking pits. And the further use of Johns-Manville Insulations on six open hearth furnaces: Sil-O-Cel C-3 Concrete for the bases; Sil-O-Cel C-22 Brick for sidewalls and slag pockets; and Superex, again, on regenerator checkers.

And on other equipment, too, including piping and reheating furnaces, J-M Insulations will add their important contribution to the minimizing of production costs.

So begins another record of superior insulation performance . . . carrying forward those already established by J-M Industrial Insulations in many thousands of plants throughout the country. Johns-Manville, 22 E. 40th Street, New York City.

Johns-Manville INDUSTRIAL INSULATIONS

An insulating material for every temperature . . . for every service condition

THE NUT and THE LOCK are a SINGLE UNIT.

No washers, pins or other separate parts to be mislaid and forgotten during installation.

FOOL PROOF—No matter how unskilled the labor.

COMPARABLE in price to the ordinary nut and lock washer, but incomparably more secure and efficient.

ANCO-NUTS used on your product will add to its value, with little if any effect on your costs.

THEY WILL PROVE INDISPENSABLE where conditions of shock and vibration must be met.

VIBRATION tends to tighten the locking, it can't unlock ANCO-NUTS.

• • • and Structural Rib Bolts and Anco Nuts answer the demands of both Engineer and Purchasing Agent.

Low first cost, as compared to rivets—ease and speed of installation, only a wrench and hammer needed—no investment in rivet heaters or air equipment—cost of replacing defective or condemned rivets is eliminated.

Specify Structural Rib Bolts and Anco Nuts on your next erection job—adaptable for use in buildings, bridges, tanks, towers and cars, their use will speed up the job and reduce labor and equipment costs.

Available in ¼" to 1⅛" diameter, in lengths to meet your requirements. Write or wire for samples and complete specifications.

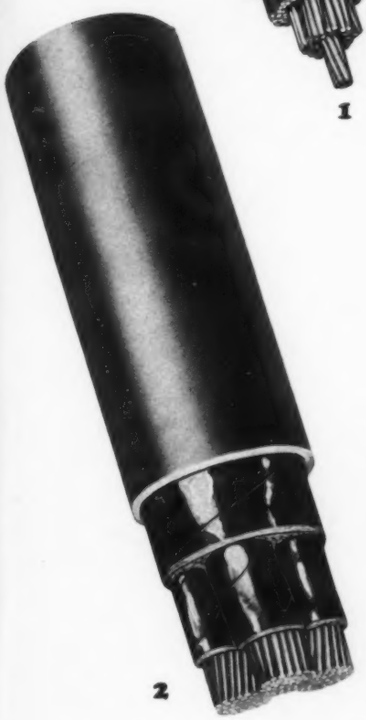
AUTOMATIC NUT COMPANY

1600 WILLOW STREET LEBANON, PENNSYLVANIA

VARNISHED CAMBRIC CABLES • RUBBER INSULATED POWER CABLES • BUILDING WIRE •

CRESCENT
WIRE and CABLE

1



2

USED TO SUPPLY and CONTROL ELECTRIC POWER for Bethlehem's New STRIP-SHEET MILL

Another "insurance policy written by Crescent" providing for low cost installation and preventing costly plant shutdowns due to cable failure. Where requirements for severe and constant use are written into the specifications you'll do it better with CRESCENT.

1. POWER CABLE
   Rubber Insulated, Braided.
2. POWER CABLE
   Varnished Cambric Insulated, Lead Encased.
3. CONTROL CABLE
   Rubber Insulated.
4. IMPERIAL CRESCORD
   Heavy Duty Portable Rubber Sheathed Cords and Cables.

3

4

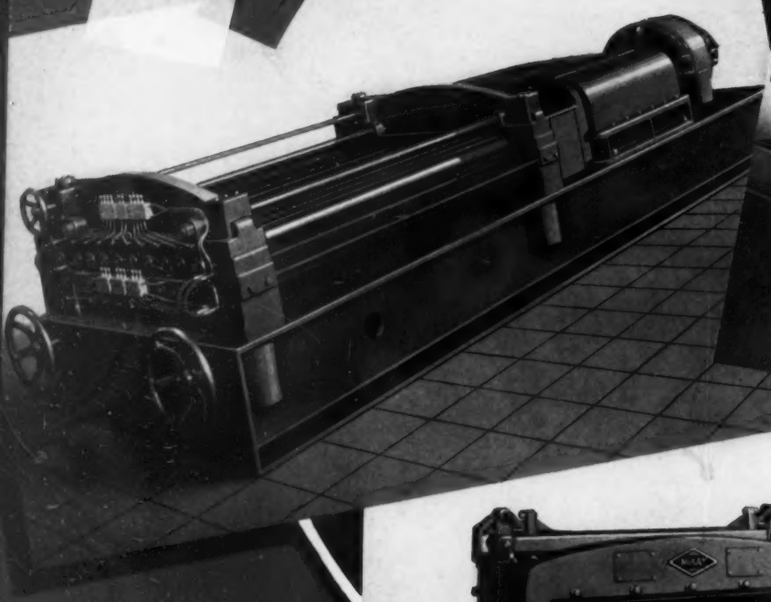
CRESCENT
INSULATED WIRE & CABLE CO. INC.
TRENTON, NEW JERSEY

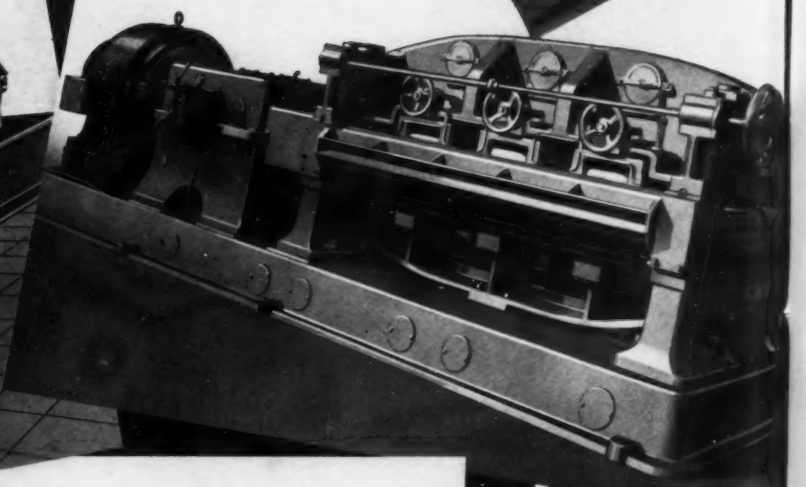
RADIO WIRES • BARE WIRE • WEATHER-PROOF WIRE • LEAD ENCASED AND PARKWAY CABLES • ARMORED CABLE

CRESCENT ENDURITE SUPER-AGEING INSULATION • SIGNAL CABLE • FLEXIBLE CORDS •

Built by McKAY

for the STRIP, SHEET & TIN PLATE Industry





The McKay Universal Drive Roller Leveler is designed to withstand heavy duty work.

The single helical gearing, used in this machine, gives a smoother operation in flattening highly finished sheets.

The McKay Up-cut Shear, used in continuous strip pickling and processing lines, starts and stops for each cut.

The McKay Backed Up Roller Leveler works the sheets thoroughly and irons out any unevenness due to either hot or cold rolling because the supporting back rolls prevent any springing of the small diameter work rolls.

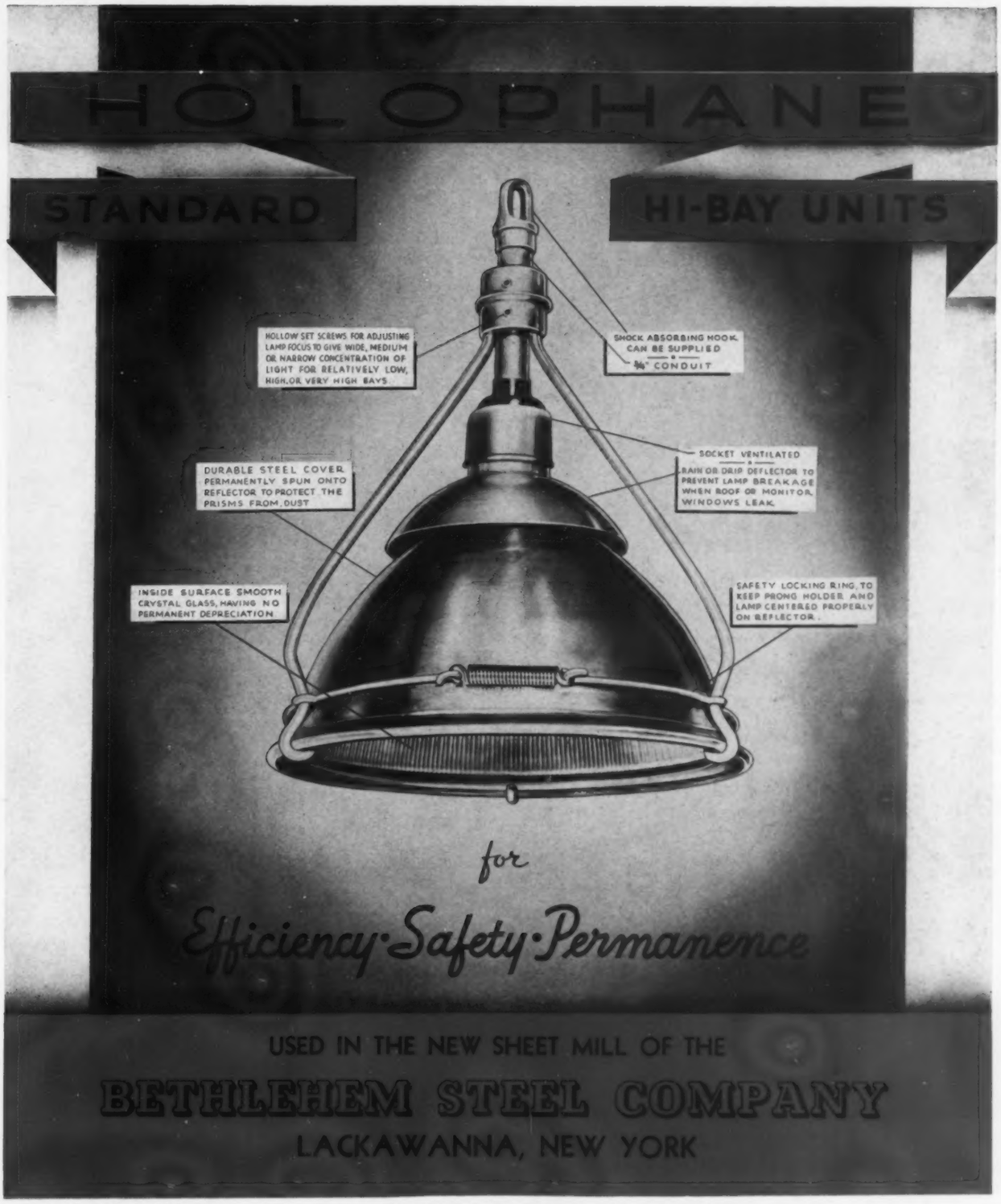
THE McKAY MACHINE CO

ENGINEERS AND MANUFACTURERS OF SHEET, TIN AND STRIP MILL EQUIPMENT

YOUNGSTOWN, OHIO

ASSOCIATED COMPANY

THE WEAN ENGINEERING CO., Inc. • Warren, Ohio


HOLOPHANE
STANDARD
HI-BAY UNITS
HOLLOW SET SCREWS FOR ADJUSTING LAMP FOCUS TO GIVE WIDE, MEDIUM OR NARROW CONCENTRATION OF LIGHT FOR RELATIVELY LOW, HIGH, OR VERY HIGH BAYS.
SHOCK ABSORBING HOOK CAN BE SUPPLIED
¾" CONDUIT
SOCKET VENTILATED
RAIN OR DRIP DEFLECTOR TO PREVENT LAMP BREAKAGE WHEN ROOF OR MONITOR WINDOWS LEAK.
DURABLE STEEL COVER PERMANENTLY SPUN ONTO REFLECTOR TO PROTECT THE PRISMS FROM DUST
INSIDE SURFACE SMOOTH CRYSTAL GLASS, HAVING NO PERMANENT DEPRECIATION.
SAFETY LOCKING RING, TO KEEP PRONG HOLDER AND LAMP CENTERED PROPERLY ON REFLECTOR.
for
Efficiency · Safety · Permanence
USED IN THE NEW SHEET MILL OF THE
BETHLEHEM STEEL COMPANY
LACKAWANNA, NEW YORK

ILLUSTRATED: No. 690 ST FOR 1000 WATT MAZDA LAMPS

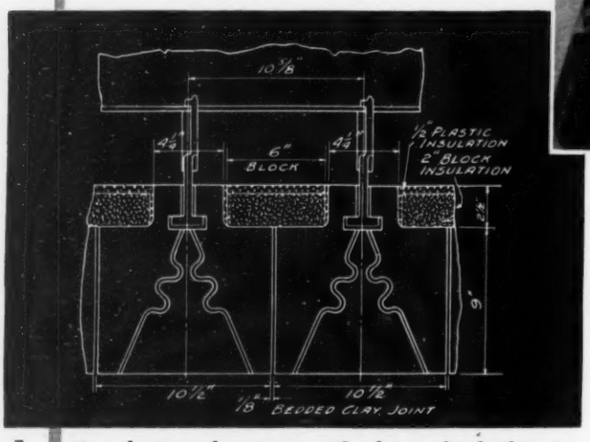
WRITE FOR ENGINEERING DATA ON HOLOPHANE HI-BAY SPECIFICS

HOLOPHANE COMPANY, INC.

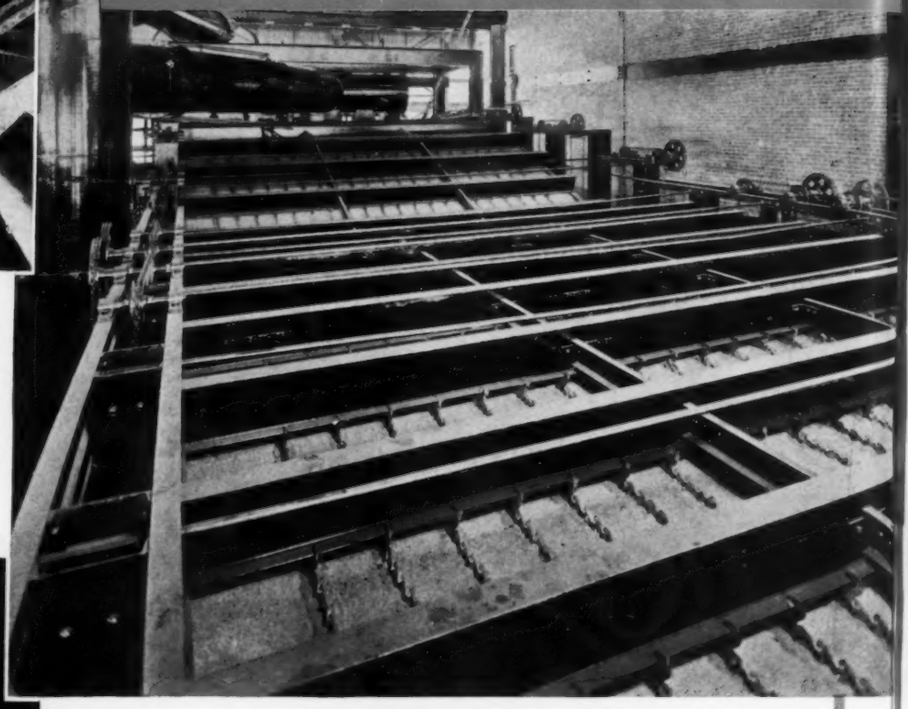
342 MADISON AVENUE NEW YORK, N. Y.

ALL 23 FURNACES

on the 8 recently built Hot Strip Mills are equipped with SIMPLEX Interlocking Nose Construction, as a Dry Lintel over the discharge door. Typical view shown above.



A sectional view showing method in which this insulation is applied. Note imbedded Hanger T does not exceed below or under the insulation.



A typical view of SIMPLEX Insulated Interlocking Arch as installed on 11 of these new Slab Heating Furnaces.

On this inspection trip be sure to see this equipment.

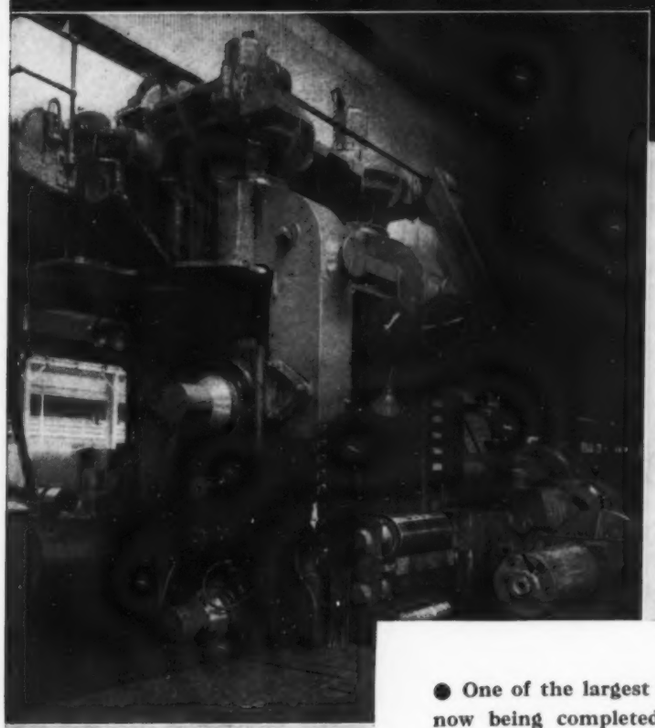
Locations of these installations will be furnished on request.

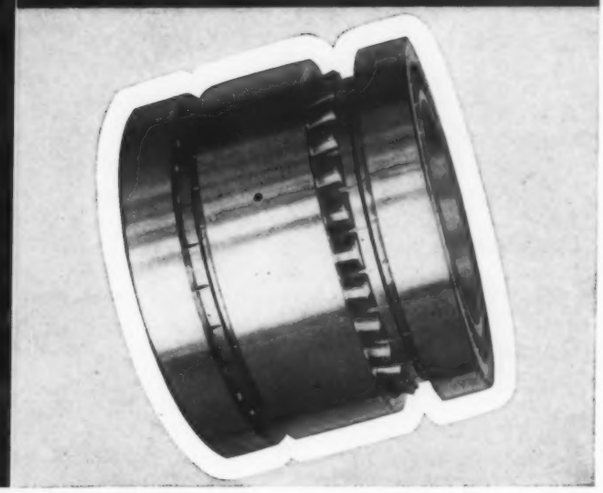
FRAZIER-SIMPLEX, INC.

ENGINEERS

WASHINGTON TRUST BLDG., WASHINGTON, PA., U.S.A.

220 BANTAM ROLL NECK BEARINGS *being used on this* BLISS ORDER!





THE BANTAM TAPERED ROLLER BEARING SHOWN HERE IS ONE OF THE TWO TYPES SUPPLIED FOR THIS ORDER. IT IS A 4-ROW TAPERED ROLL NECK BEARING, SIZE 18" x 30" x 20¾".

● One of the largest orders ever placed for Bliss Temper Pass Mills is now being completed. To secure maximum service and continuous customer satisfaction Bliss is using 220 *Bantam* Roll Neck Bearings on this installation. The bearing shown is one of the two types of *Bantam* Bearings used. *Bantam* Straight roller bearings are being used on work roll necks.

Bantam bearing quality assures longer bearing life. To achieve this quality, *Bantam* puts a premium on better workmanship. This results in greater accuracy. Bearing designs have been developed, tested and perfected over a period of years. Only the finest steel is used. *Bantam's* one-piece bronze lubricages give maximum lubrication.

Whether your next order is for 2 bearings or 220, it will pay you to specify *Bantam*.

BANTAM BEARINGS CORPORATION
SOUTH BEND, INDIANA
Subsidiary of THE TORRINGTON CO.
Torrington, Conn.

BANTAM BEARINGS

TAPERED ROLLER • • • STRAIGHT ROLLER • • • BALL BEARINGS

Republic Steel Opens

NEW TIN PLATE MILL

500 Attend Opening of New Structure Costing $3,500,000

▲ REPUBLIC Steel Corporations' new strip tin plate plant at Niles, Ohio was officially opened on March 11 with an inspection trip by the Republic officials and the citizens of Niles. In locating this new mill it was decided to use the abandoned buildings of the old No. 1 sheet mill plant of the Niles works. Removing the old equipment and reconditioning old buildings started the first part of September, 1936 while excavation for the new buildings and equipment started October 14.

The strip tin plate plant covers a total area of 300,000 sq. ft. of floor space, of which 177,000 sq. ft. is in the old reconditioned buildings. The new buildings required 1,300 tons of structural steel, and the foundation work for buildings and machinery is made up of 15,000 cu. yds. of concrete, requiring 23,000 cu. yds. of excavation, 15,000 cu. yds. of slag fill, and 11,600 ft. of piling.

The hot strip coils will be rolled on No. 1 hot strip mill at Warren Works, and shipped to Niles Works, and stored in the coil storage building, and then transferred to pickle building and run through 36″ continuous pickler, which has a maximum speed of 150 ft. per minute.

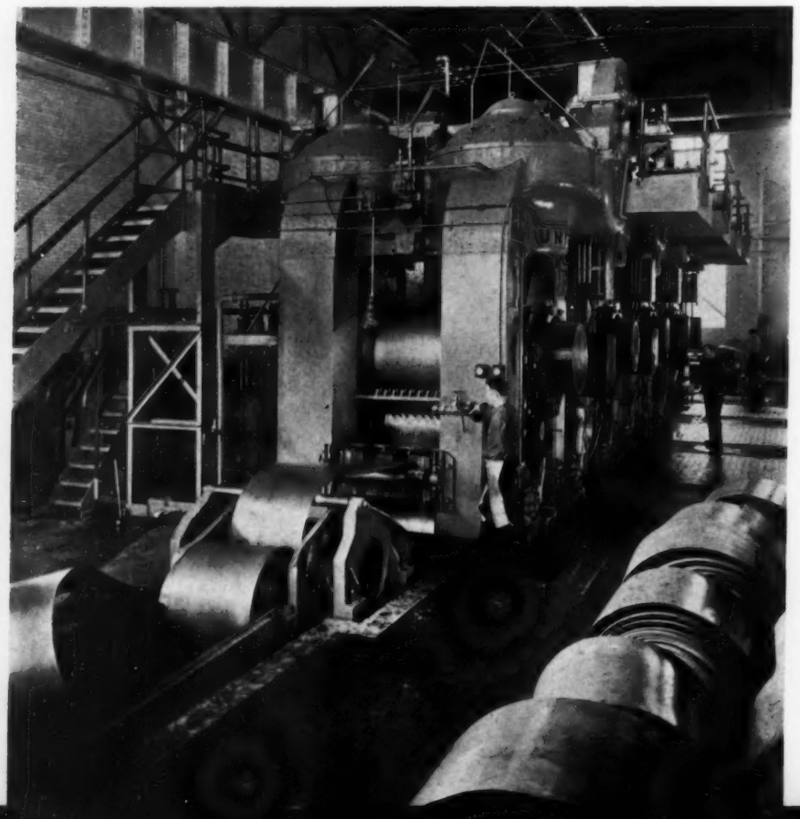
After pickling and oiling, the coils of steel are transferred to the tandem mill building and cold reduced on a 4-Stand tandem cold strip mill, down to tin plate gages, at a top speed of 1350 ft. per minute.

The cold strip mill consists of 4 Stands of 4-Hi cold mills, having rolls 18″ and 49″ diameters by 42″ face. Each stand is driven by a DC electric motor of 500, 1000, 1000, and 1500 HP, respectively.

The mill is equipped with automatic tension devices and flying micrometers.

The rolled steel is wrapped onto the reel on the fly without stopping.

After cold rolling on the mill, the coils of strip steel are run through two (2) electro cleaning and cutting lines, where the oil is removed from the strip, the sides trimmed, and the strip is cut to lengths, at a speed of



Entry end of four-high mill showing coils which have passed through pickler entering mill.

Main motor room of new strip tin plate mill at Republic Steel Corporation, Niles Plant.

500 ft. per minute, and piled for the next operation of box annealing. The cut lengths are now called black plate.

The piles of plate are then transferred to the annealing building, where we have located, eight (8) double chamber "in" and "out" type box annealing furnaces with an electric portable charging machine.

The stacks of black plate are then box annealed, after which they are delivered to the 2-Hi tin cold rolls for cold rolling.

The 2-Hi cold rolls are arranged in 4 tandems of 3 stands each, and are driven with three (3) 500 HP motors. The rolls are 24″ in diameter and 44″ and 48″ long. The cold rolled plate is then transferred to the White Pickler for pickling. The White Pickler is a vertical engine type, operated with compressed air. The plate is then placed in Boshes, and held in the Bosh Storage, preparatory to tinning. The Boshes are then transferred to the tinning machines with an overhead electric crane, and the plate is automatically fed through straight-away tinning machines and cleaners to automatic pilers. There are eight (8) straight-away tinning machines and cleaners, seven (7) of which are 64″ 2-way machines, and one (1) 75″ 3-way machine.

The piles of tin plate are then trucked to the assorting room for assorting, and then to the boxing, storage and shipping warehouse. Both the tin house and assorting room include all modern features, and are adequately ventilated and air conditioned.

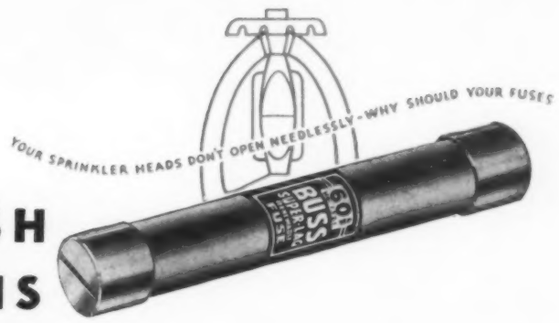
The continuous pickler and the 4-Stand tandem cold mill were started in operation, February 4th.

The plant, in general, is so laid out and arranged so that the order of processing of steel will be in a continuous line.

Delivery end of four-high mill showing gauger and control panel. Belt is also visible.

MR. H. H. WHITE, Chief Electrician for Blue Diamond Corp., Los Angeles, speaking. He continues "We use 25 hp motors on our calcining kettles. When the plaster is fed in too fast the motor stalls. We have to break it loose by throwing the current on and off momentarily. This severe service kept blowing ordinary fuses. We heard about BUSS super-lag fuses — tried them — and found that they were the only fuses that could 'take it' without causing needless shutdowns. Now we have standardized on them throughout our plant."

made to Protect . . . not to Blow!



• you too, CAN ABOLISH WASTEFUL SHUTDOWNS *caused by* NEEDLESS BLOWS

It may come as a surprise to some executives that many equipment shutdowns supposed to be caused by trouble in the circuit, really originate in the protective devices themselves.

To prevent such costly waste—caused by protective devices opening needlessly—BUSS developed the Super-Lag fuse.

If you are even remotely interested in a smooth running plant—or in saving money due to more efficient plant operation—you will find it well worth while to inform yourself as to . . .

WHY BUSS FUSES DON'T BLOW NEEDLESSLY

The

10 FEATURES *and* SUPER-LAG

in the design of the FUSE-CASE help make it possible development in the FUSE LINK completes the job.

GET THE FACTS

You will find this new book on fuses of refreshing interest.

It sets up in concise, fast reading style, the facts about fuses and their relation to the cost of plant operation.

It will give you authoritative information that will be valuable to you in any discussion of fuses or any feature of the problem of electrical operation.

Your name and address will bring you a free copy. Just ask for the Rb book on "Fuses made to protect—not to blow."

BUSSMANN MFG. CO.
University at Jefferson
St. Louis, Mo.
Division of McGraw Electric Co.

Buss Super-Lag Fuses are available thru Electrical Wholesalers

BUSS Super-lag FUSES

TRY THIS NEW LINCOLN!

TRY the new *"Shield-Arc SAE"* with 3/32-inch electrode on 24-gauge sheet or, turn up the heat and use it with 3/8-inch electrode on heavy plate. Just try it on any kind of work . . . with any size electrode . . . and you will find this new Lincoln gives the widest range of welding arcs ever afforded by any one welder.

You will also find it *easier* to get *better welds* at *higher welding speed* throughout this *"Shield-Arc's"* extra wide range because its Dual Continuous Control permits the choice of *any type* of arc as well as *any size,* to suit each job individually.

This vastly improved welder performance is being realized in everyday practice by scores of users of the new *"Shield-Arc SAE."* May we arrange a demonstration for you? The coupon is for your convenience. THE LINCOLN ELECTRIC CO., Dept. Z-337, Cleveland, Ohio. *Largest Manufacturers of Arc Welding Equipment in the World.*

Any TYPE or SIZE of arc . . . as simple to get as a station on your radio. Here is the engine-driven "Shield-Arc SAE," *for use out in the field.*

"SHIELD-ARC SAE"

—the New Lincoln Welder with

DUAL *Continuous* CONTROL

and Self-Protecting Motor

THE LINCOLN ELECTRIC CO.
Dept. Z-337, Cleveland, Ohio

☐ Arrange for us a demonstration of the new *"Shield-Arc SAE"* Welder.

☐ Send Bulletin 412 describing this new welder.

Name ..... Position .....

Company .....

Address .....

City ..... State .....

OFFICIAL PROGRAM

Spring

ENGINEERING CONFERENCE

Buffalo, N. Y.

APRIL 28-29, 1937 HOTEL STATLER

●

On the three following pages will be found the list of authors, papers to be presented, officers of the meetings and complete details of the inspection trip.

●

INSPECTION TRIP

THURSDAY, APRIL 29 -- 3 P. M.

BETHLEHEM STEEL CO., LACKAWANNA, N. Y.

OFFICERS FOR WEDNESDAY EVENING APRIL 28

Chairman—J. A. CLAUSS
Chief Engineer, Great Lakes Steel Corp., Ecorse, Michigan.

Vice Chairman—H. E. DAVIS
Electrical and Mechanical Superintendent, Republic Steel Corp., Buffalo, N. Y.

Wednesday Evening April 28

8:00 P.M.

"Radiant Tube Annealing Covers" by R. J. Cowan, *Surface Combustion Corp., Toledo, Ohio.*

"Electrical and Mechanical Developments of Modern Cold Strip Mills" by A. F. Kenyon, *Westinghouse Electric & Manufacturing Company and John L. Young, United Engineering & Foundry Company, Pittsburgh, Pa.*

M. J. CONWAY
Author

JOHN L. YOUNG
Author

OFFICERS FOR THURSDAY EVENING APRIL 29

Vice Chairman T. E. HUGHES
Superintendent Maintenance Dept., Carnegie-Illinois Steel Corp.,Duquesne, Pa.

Chairman F. D. EGAN
Superintendent Electrical Department, Bethlehem Steel Company, Lackawanna, N. Y.

Thursday Morning April 29

9:30 A.M.

"Some Heating Furnace Control Problems by Martin J. Conway, *Fuel Engineer, Lukens Steel Company, Coatesville, Pa.*

"Diesel Electric Locomotives in Steel Mill Service" by F. H. Craton, *General Electric Co., Erie, Pa.*

"Simplicity of Stress Distribution in Arc Welded Joints" by E. W. P. Smith, *Lincoln Electric Company, Cleveland, Ohio.*

A. F. KENYON
Author

E. W. P. SMITH
Author

INSPECTION TRIP

Hot and Cold Strip Mill

BETHLEHEM STEEL CO.

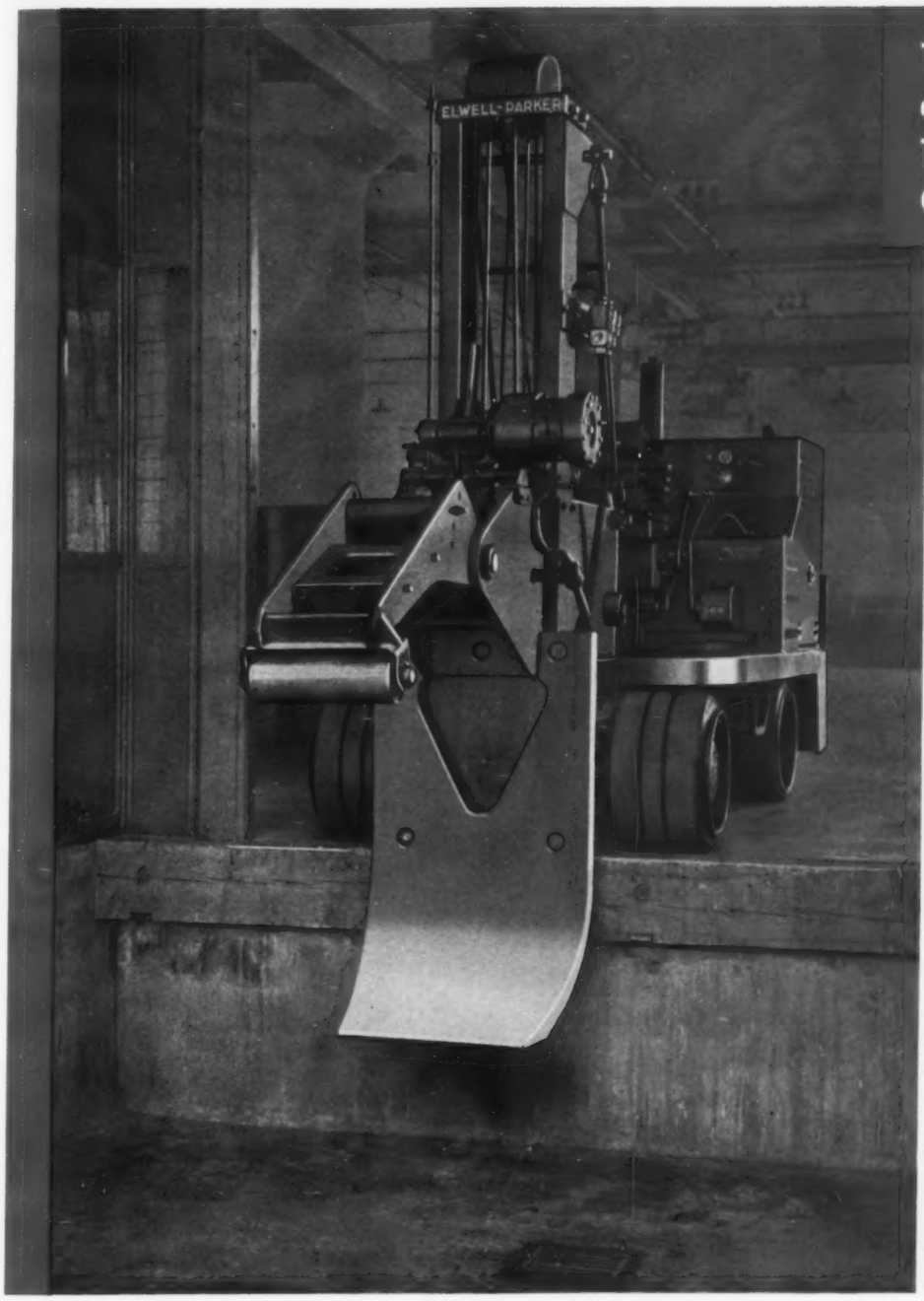
Lackawanna, N. Y.

Continuous strip sheet and plate mill at Lackawanna Plant, Bethlehem Steel Co., Lackawanna, N Y.

THURSDAY APRIL 29 - 3:00 P. M.

The Bethlehem Steel Company has extended an invitation to the members and guests to inspect its new continuous Hot and Cold Strip Mill. This trip *must* be made in *special buses* leaving the *Hotel Statler* at 3:00 P.M. The price per person will be $1.50.

ASSOCIATION OF IRON AND STEEL ENGINEERS



The Complete Line of Elwell-Parker Trucks, Tractors and Cranes Provides:—

1. Every type of Equipment Required for Low-Cost Materials Handling in Steel Plants.

2. Principal Types available at customer's option for Gas, Gas-Electric or Electric Power.

3. Principal steel-transporting operations can be done at major savings by *standard* Elwell-Parker Trucks with suitable lifting attachment. For example:

a—Gripper for coils to be carried crosswise truck. (See illustration.)

b—Ram for coils to be carried lengthwise truck.

Pick-up or delivery can be made to or from floor level or pit.

c—Forks for flat sheets.

4. Trucks of special types designed when unusual conditions make it necessary, by Elwell-Parker's especially-trained Steel Plant Transportation Engineers.

5. All Elwell-Parker Trucks have interchangeable parts.

● With the acceptance by the Steel Industry of Power Industrial Trucks, Elwell-Parker is filling today's requirements for this type of machine—building among the heaviest required for the fast transportation of coils between pickler, rolls, rotary shears, storage and shipping. For over 25 years, Elwell-Parker has pioneered successfully in helping steel to reduce its handling costs. Elwell-Parker Engineers know steel—we'll send one to consult with your own staff on that new important job. You set the date. The Elwell-Parker Electric Company, 4504 St. Clair Avenue, Cleveland, Ohio.

New Type ELWELL·PARKER *Trucks*

ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

ITEMS OF INTEREST

S. S. Marshall, Jr., general manager, Jones & Laughlin Steel Corp., has just been elected vice president in charge of operations and a director of the corporation. This is the third promotion in two years for Mr. Marshall.

Mr. Marshall, who has been general manager of operations since January of this year, started with Jones & Laughlin in 1903 in the engineering department of the Pittsburgh works. In 1914 he became master mechanic of the Northside works, along Second Avenue, and in 1917 assistant general superintendent of the Eliza works. In 1925 he was made assistant general superintendent of the Southside works.

A year later, Mr. Marshall became general superintendent of the Pittsburgh works and held that position until 1936 when he was made assistant general manager of operations, subsequently being made general manager.

S. S. MARSHALL, JR.

▲

Charles F. Langer, assistant superintendent of the cold strip department at the Warren works of Republic Steel Corp., has been transferred to Cleveland to act as superintendent of the new 98-in. cold strip mill now under construction. After attending Carnegie Institute of Technology in Pittsburgh, Mr. Langer was employed by the engineering department of the Superior Steel Co., Pittsburgh, in 1914 and in 1924 went to the Blair Strip Steel Co., New Castle, where he was employed as superintendent. In 1926 he became assistant superintendent of the hot strip mills of the Weirton Steel Co. He went to Warren in 1928 as turn foreman in the cold strip department and was appointed assistant superintendent of the department in 1935.

James E. Lose, vice president in charge of operations, Carnegie-Illinois Steel Corp., was honored March 22, when one of the largest steamers belonging to the Corporation was given his name.

Mr. Lose became a vice president of Carnegie Steel Company on August 1, 1933, and was made vice president in charge of operations when the Carnegie-Illinois Steel Corporation was formed in the fall of 1935.

He began his career with the company in June 1909, as an office boy at Carrie Furnaces, part of the Homestead Works. He became assistant superintendent of Carrie Furnaces on June 1, 1919; superintendent in September 1924; assistant general superintendent of Homestead Works in April 1928; and, general superintendent in October 1930. He held this position until promoted to the office of vice president.

JAMES E. LOSE

▲

W. A. Jayme, has been appointed general superintendent of the W. DeWees Wood Works, Carnegie-Illinois Steel Corp., McKeesport, succeeding the late H. H. Giles.

Mr. Jayme, a graduate of the Massachusetts Institute of Technology in 1921, was manager of the alloy division, metallurgical department, prior to his new appointment.

His career with Carnegie-Illinois has been relatively short, as he came into the company in November 1935. He began as contact man of the metallurgical department, and took the position of manager of the alloy division in June 1936.

Before coming to Carnegie-Illinois, Mr. Jayme was employed by the Crucible Steel Company of America, Park Works; the United Alloy Steel Company, Can-

ton, Ohio; the Reading Iron Company, Reading, Pa.; and, for a short time only, the Studebaker Corporation, South Bend, Indiana.

Carl M. Nystrom, who has been acting superintendent since the death of Mr. Giles, will be the assistant general superintendent.

Mr. Nystrom, whose schooling included four years of extension work at Carnegie Tech, began as a metallographist for the company in January 1926. He was appointed foreman of the chrome polishing and inspection department on December 1, 1928.

▲

C. J. Duby, for the past six years chief engineer of the Warren district of the Republic Steel Corp., has been appointed chief engineer of the Youngstown-Warren district following a general organization plan recently adopted under which the Youngstown and Warren mills of Republic were combined into one operating district. E. H. Koenig, formerly chief engineer of the Youngstown district, has resigned.

A native of Scranton, Pa., Mr. Duby's first position in his chosen line of activities was as a field engineer for the Eastern Steel Co. in Pottstown, Pa., In 1917 he went with the Republic Iron & Steel Co. as mechanical engineer in the engineering department. In 1922 he was made manager of the Youngstown fabricating plant and later became chief draftsman of the Trumbull Steel Co. at Warren. He was appointed assistant chief engineer in 1929 and in 1931, after the Republic merger, was made chief engineer of the Warren district.

▲

R. J. Wysor, executive vice president and general manager, Republic Steel Corporation, has been elected president of the corporation, succeeding Tom M. Girdler who will continue as chairman of the board. Mr. Girdler has held both positions.

Mr. Wysor has been active in the steel industry for over 30 years. Starting with the Carnegie Steel Company as a chemist, he subsequently became chief chemist of the Bethlehem Steel Company, Bethlehem; superintendent of the Bethlehem blast furnaces and from there to the position of superintendent of the service division. In 1919 he was made assistant general manager of the Sparrows Point plant. In 1923 when Bethlehem acquired the Cambria Steel Company, Johnstown, Pa., he was made the assistant general manager.

Two and a half years later Mr. Wysor went with the Jones and Laughlin Steel Corporation as assistant general manager. When T. M. Girdler was elected president of Jones and Laughlin in 1929 Mr. Wysor succeeded him as general manager.

Late in 1929 when the Republic Steel Corporation was organized he joined this company as the vice president in charge of operations, becoming executive vice president and general manager in September 1935.

▲

George L. Stout, Pittsburgh District Manager, Colts Patent Firearms Manufacturing Company, electrical division, announces the opening of an office at 919 Empire Building, Pittsburgh, Pa. Mr. Stout has been a member of the Association for the past eleven years. J. A. Classin will assist Mr. Stout.

▲

A. A. Van Pelt, manager, Pittsburgh office, Norma-Hoffmann Bearings Corporation, announces that his office has been moved from 105 Fahnestock Road to Room 722, Gulf Building.

▲

William E. Kane, founder and president of Kane and Roach Company, Syracuse, New York, manufacturers of straightening machinery, was one of the early pioneers in this type of machinery manufacture. This year finds his company celebrating its fiftieth anniversary. It has been a very successful business enterprise, much of the credit being due Mr. Kane, under whose direction the first straightening machinery was manufactured in this country.

C. J. DUBY

R. J. WYSOR

WILLIAM E. KANE

H. A. WINNE

J. J. HUETHER

S. W. CORBIN

H. A. Winne, manager of sales, mining and steel mill section, General Electric Company, effective, April 1, will join the engineering department of this company as general assistant to Vice President R. C. Muir.

Mr. Winne, a native of Cherry Valley, N. Y., attended Syracuse University, graduating in 1910 with a degree in electrical engineering. The same year he entered the employ of the General Electric Company as a student engineer in the testing department. In 1911, he became head of the large motor, generator, and synchronous converter test, and about a year later was made assistant general night foreman of the testing department. In 1916, he was promoted to the power and mining engineering department, now the industrial department, and there worked on problems concerned with industrial heating, arc welding, and electric furnace equipment. He was transferred to the industrial engineering department's steel mill section in 1922 and became head of that section in 1930. In 1936, he was appointed manager of sales of the combined mining and steel mill section, the position he occupied until his latest promotion.

▲

J. J. Huether, manager, sales machinery section, will succeed Mr. Winne.

Mr. Heuther was born at Sharon, Pa., and is a graduate of Notre Dame with the class of 1922. In 1923, he entered General Electric's testing department and later that year was transferred to the alternating current engineering department. He became associated with the industrial department in 1924, under J. E. N. Hume, then manager of the steel mill section. He remained with that section, after its combination with the mining section under K. H. Runkle, until 1931, when he was appointed manager of sales, machinery manufacturers' section, succeeding J. P. Jones.

S. W. Corbin has been appointed to take over Mr. Huether's work.

Mr. Corbin, while a native of Philadelphia, resided in Schenectady for several years prior to his connection with General Electric. He attended Union College, where he was affiliated with Sigma Phi fraternity, graduating in 1930 with a degree in electrical engineering. He entered the G. E. test course the same year, and in 1931 joined the machinery manufacturer's section of the industrial department, the section that he now heads as manager of sales.

▲

C. R. Bottenfield, formerly superintendent of the 80″ and 42″ mills at the Gary Sheet and Tin mills of the Carnegie-Illinois Steel Corp., has been appointed general superintendent of the new tin mill of the Tennessee Coal, Iron and Railroad Company, a subsidiary of the U. S. Steel Corporation.

Mr. Bottenfield will be succeeded by L. S. Dahl, who up to the present time has served as superintendent of the cold reduction and annealing departments. Mr. Harry Gude, assistant superintendent of cold reduction, will take over Mr. Dahl's title and duties, and will be succeeded by Mr. A. L. Billeter, who has been assistant superintendent in charge of annealing at the sheet and tin mills. Mr. Ross O. Laub will become the new assistant superintendent in charge of annealing. All appointments were effective April 1.

Mr. Bottenfield came to the Gary Sheet and Tin mills on June 1, 1919. Previously he had taught school at Milltown, Indiana and had served in the United States Army as Second Lieutenant of Artillery during the war.

Beginning as a mechanic's helper in the machine shop of the tin mill, Mr. Bottenfield served successively as scrap press mechanic; tin house shop machinist; machine shop foreman; master mechanic; master mechanic of the roughing mill; and night superintendent of the 42″ hot strip mill. Later he became day superintendent in charge of hot and cold rolling. Mr. Bottenfield became superintendent of the cold reduction department before his promotion to his present position as superintendent of the 80″ and 42″ hot strip department.